LITERATURE SUPPORT · FAULT DATA

Fault Data in Laboratory Ventilation Inspection Reports

An annotated sourcebook of peer-reviewed studies, standards and open datasets that quantify failure rates, failure modes and root causes in laboratory ventilation systems — with citation-ready findings for use in inspection reports.

Compiled 18 October 2026 **Source types** Journal · Conference · Thesis · Standard · Open dataset **Entries** 21
Languages English · Chinese

00 How to use this document

Read this first — it prevents most citation errors.

One finding dominated the search: **literature that directly addresses laboratory ventilation inspection rarely contains usable fault statistics.** The numbers that do exist are scattered across three distinct bodies of work: **(1)** field performance studies of fume hoods and biosafety cabinets, which report non-compliance rates; **(2)** fault detection and diagnosis (FDD) research on building VAV terminals and air handling units, which reports fault frequency and fault-type distribution; and **(3)** inspection summaries published by industry bodies and vendors, which offer many numbers but no peer review.

This sourcebook separates the three, and grades every entry for credibility. **The three sets of figures rest on different definitions and denominators and must not be pooled or compared directly.** Each is valid only as evidence of a proportion within its own measurement basis.

Credibility key
Peer-reviewed journal, conference or thesis — citable as a formal reference Standard national, industry, ANSI or ASHRAE — use as the acceptance criterion Industry association, testing body or vendor technical paper — supporting evidence only Marketing promotional content — **do not cite**

01 Key figures at a glance

The six numbers most likely to be challenged in a review meeting.

27%
Fume hoods with face velocity inside 0.4–0.6 m/s
295 hoods measured, Univ. of Kuopio, Finland

2.7%
Hoods passing *all* performance criteria
Same study — only 8 of 295

20.9%
VAV terminals found ineffective
Site survey of 1,251 terminals, Hong Kong

30–50%
Containment leakage above guideline despite compliant face velocity
ASHRAE 110 tracer gas testing

44.4%
Class II BSCs passing all test items
18 cabinets, full-protocol hospital survey

17.5%
Class II BSCs passing all test items
126 cabinets, veterinary institutes

The 44.4% and 17.5% figures do not contradict each other. The first covers 18 cabinets judged on a narrower item set; the second covers 126 cabinets judged on nine items, where failure of any single item fails the whole cabinet. Always report the sample size and the pass rule alongside the rate, or the figure will not survive review.

02 Field-measured failure rates

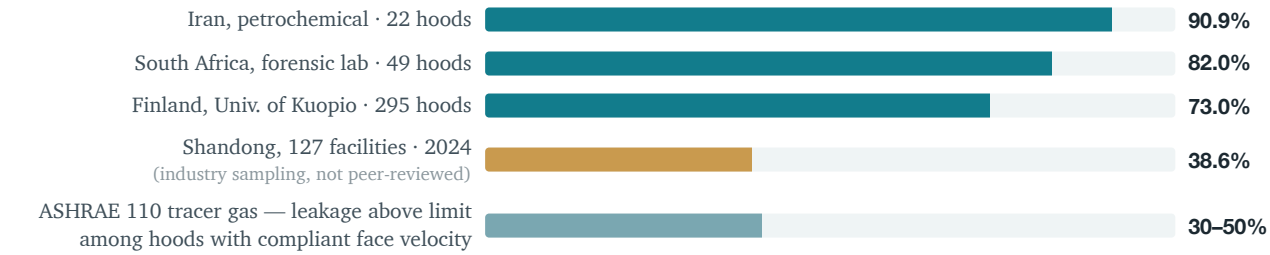
The hardest evidence available — all measured on site, none simulated.

2.1 Fume hoods and exhaust hoods

Study	Sample	Criterion	Pass / fail	Root causes (as stated)
Pasanen et al. Peer-reviewed	295 hoods (of 303 inspected)	Face velocity 0.4–0.6 m/s; Finnish code exhaust 140 L/(s·m)	**27% met face velocity** (79) 22% met exhaust flow (65) Mean face velocity only 0.35 m/s 22 hoods (7%) below 0.2 m/s, taken out of service	Systems dating from the 1970s–80s; new hoods added to old fans without upgrading; jammed dampers; debris inside ductwork; wrong type or position of supply diffusers, producing up to 3 m/s near hood faces; hoods sited near doors
Pasanen et al. (sub-items, same study)	220 hoods full protocol	Velocity profile within ±20%; turbulence CV ≤ 15%	Velocity profile **27%** (60) Turbulence criterion **5%** (12) All criteria **2.7%** (8/295)	Demonstrates that a compliant mean conceals large low-velocity zones and eddies; a single averaged value does not represent containment
Petrochemical plant, Iran ASHRAE 110 assessment Peer-reviewed	22 hoods	Face velocity ≥ 80 fpm (0.41 m/s) plus SF_6 tracer gas	Face velocity **9.1%** (2/22) Tracer gas **4.5%** (1/22)	The two tests were **uncorrelated**: no hood passing face velocity passed tracer gas, and vice versa. Conclusion: face velocity is a supplementary test only
Jacobs P.J. Univ. of the Witwatersrand Thesis	49 hoods 11 months	0.51 m/s ± 20% (institutional standard, SAPS Forensic Laboratory)	82% operating outside standard 12% below 0.41 m/s; 70% above 0.61 m/s Out of service: 14% at start → 27% at end, peaking at 47%	Failure is not only insufficient airflow — **excess airflow is equally a failure** (turbulence releases contaminants, wastes energy); fan stoppage gave no indication whatsoever

Non-compliance with face-velocity criteria, by study

Criteria differ (0.4–0.6 m/s or 0.51 ± 20%) as do samples and test conditions. Indicative of magnitude only; do not pool.



2.2 Biosafety cabinets (BSC)

Study	Sample	Overall pass rate	Where failures concentrate
Class II BSC safety performance evaluation *Chinese Journal of Disinfection*, 2024 Peer-reviewed	18 cabinets (A2 / B2)	**44.44%** A2 50.0%; B2 40.0%	Inflow HEPA leak rate, UV irradiance and cleanliness all passed at 100%. **Illuminance** passed at 94.44%. Downflow 0.29 m/s and inflow 0.57 m/s — close to the 0.25 m/s lower limit
Performance testing of Class II BSCs in veterinary institutes *Laboratory Animal and Comparative Medicine*, 2022 Peer-reviewed	126 cabinets (3 institutes, Harbin)	**17.5%**	Appearance, cleanliness, supply/exhaust HEPA leak test, airflow pattern and alarm interlock all 100%. **Inflow velocity only 49.2%**, **noise only 22.2%**, illuminance 68.3%, downflow 92.9%
23 Class II BSCs at a tertiary hospital Guangzhou Institute of Measurement (industry) Industry	23 cabinets	—	Inflow velocity non-compliance **26%** (highest); noise 17%; illuminance 9%; downflow 9%; HEPA integrity 9%; airflow pattern 4%; cleanliness 4%
HEPA integrity spot-check, 12 BSCs (testing-body technical note) Industry	12 cabinets	Under the original YY 0569 criterion: **0 passed** Under a relaxed provincial criterion: 6 passed	Failure correlates strongly with **service life**: 3 years without filter change → slight exceedance; 5 years of heavy use → 10–30% penetration; over 10 years → >60% penetration, cabinet could not be pressurised to 500 Pa, condemned

> **This is the most valuable chain of evidence in the whole set.** Service life → filter replacement record → penetration rate forms a three-stage argument that directly supports the claim that failures are not random but tightly coupled to maintenance intervals. Present it as a service-life-versus-failure relationship rather than a single rate.

2.3 Ductwork and system level

Indicator	Value	Notes and source
Exhaust ducts with condensate accumulation and microbial growth	29.1%	Shandong sampling of 127 industrial and institutional laboratories (2024), Industry; sampling method and criteria not disclosed
Systems without air-balancing devices, causing reverse flow between adjacent rooms	17.3%	Same source. Points to **system-level imbalance** rather than single-unit faults
Failure modes from supply/exhaust imbalance	qualitative	Supply too low → excessive negative pressure, doors hard to open, whistling, insufficient face velocity. Supply too high → positive pressure, contaminants escape to corridors. Supply jet above 2 m/s directed at the working opening → eddies that destroy piston-type capture
Time to VAV component failure	3–5 years	Vendor experience with electromechanical wear, Marketing; order-of-magnitude reference only

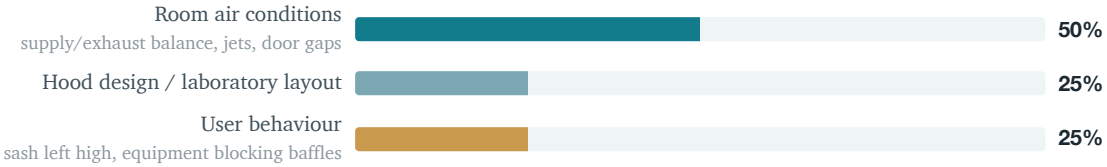
03 Failure modes and attribution

The attribution split that the root-cause chapter of an inspection report almost always lacks.

3.1 Why hoods lose containment

Attribution of ASHRAE 110 tracer-gas test failures

Source: NEBB, The Myth of Face Velocity Reloaded — a retrospective across a large body of on-site tracer-gas failures. The three categories sum to 100%.



The same source records a finding with considerable rhetorical force: **more than 80% of hoods that failed the tracer-gas test had a "compliant" face velocity.** This corroborates the Iranian petrochemical result in §2.1 — that face velocity and tracer gas performance are uncorrelated — and together they form a dual foundation for the argument that face velocity alone is an inadequate acceptance criterion.

3.2 Failure mode inventory (usable as a fault tree or checklist)

Level	Failure mode	Observable symptom	Cause or share, per literature
Terminal device	Face velocity too low	Below 0.3–0.4 m/s; odours escaping; frequent alarms	Filter or baffle blockage, duct leakage, worn fan belts, undersized branch ducts, simultaneous use competing for airflow
	Face velocity too high / turbulent	Above 0.6–0.7 m/s; smoke test shows roll-in at the airfoil	System airflow imbalance, insufficient local make-up air, oversized fan selection (70% of the South African sample)
	Non-uniform velocity field	Left–right or top–bottom spread above 20%; single-point minimum far below mean	Baffle angle misalignment (a 47% left–right difference measured), equipment obstructing the interior, sash above working height
	Cabinet and component degradation	Sash sticking, control panel failure, baffle corrosion perforation	Prolonged exposure to hydrofluoric or concentrated nitric acid; sash gasket embrittlement and loss
Control system	Face-velocity sensor drift or failure	Reading jumps when people walk past; large deviation from reference measurement	Hot-wire probes sensitive to disturbance; sensor mounted in an eddy zone; calibration overdue (annual calibration advised)
	Damper actuator sticking or under-torque	Command issued but stroke incomplete; cannot close fully at maximum airflow	Mechanical seizure, undersized torque; prior probability of actuator failure 3.8% in the Bayesian-network study
	Control algorithm lag or oscillation	Face velocity dips then overshoots when the sash moves; damper hunting	Rigid PID parameters, response time above 3 s, static-pressure sensor mounted too close to an elbow and reading turbulent pressure
	Room temperature / pressure sensor fault	Temperature control offset; displayed differential disagrees with measurement; pitot tube blocked	Sensor fault prior probability 25.3%, far above actuator; uncalibrated or badly located

Level	Failure mode	Observable symptom	Cause or share, per literature
System level	Loss of air balance	Reverse flow between rooms, corridor odours, doors hard to open or whistling	No balancing device fitted (17.3%), supply/exhaust ratio out of adjustment, no re-balancing after system modification
	Faults detected late for want of monitoring	Average 72-hour lag before a fault is noticed	No online fan-status monitoring, insufficient BMS points, no trend logging

04 HVAC fault prevalence statistics

Laboratory ventilation is, in control terms, a VAV system. This literature has large samples and transparent methods, making it the most reliable source for fault frequency.

4.1 Large-scale fault census (LBNL / PNNL)

A US Department of Energy Building Technologies Office study pooled data from eight commercial FDD platforms, covering **317 buildings, 33,660 air handling units and 153,865 air terminal units**. Principal findings:

Metric	Value	Interpretation
At least one fault present on a given day	AHU 40% ATU 30%	Operating with faults is the norm, not the exception
Mean fault count	3 per AHU per month	Faults are highly concurrent; single-fault diagnostic assumptions do not hold
Most common AHU faults share of affected equipment	Supply-air temp sensor 55% Static-pressure setpoint 40% Cooling-coil valve 35% Schedule 34% Economizer sequence 31% Supply fan 30% Outdoor-air damper 30%	Sensing and control faults dominate; mechanical faults follow
Most common ATU faults	Zone temp sensor 46% Reheat-coil valve 34% Discharge airflow 31% Heating 28% Discharge-air temp sensor 28%	Structurally very close to the fault spectrum of laboratory VAV terminals

4.2 VAV terminal site survey (Hong Kong, 1,251 units)

Qin and Wang surveyed **1,251 pressure-independent VAV terminals** in a large commercial building in Hong Kong and found **20.9% of terminals ineffective**, resolving these into **eleven root faults**. The study identifies zone temperature sensor error and local DDC controller error as the two most common faults. This work has become the benchmark dataset in VAV terminal FDD and is cited repeatedly in subsequent literature.

> **Why this transfers to laboratories:** laboratory VAV terminals share their hardware with commercial terminals — damper, flow loop, temperature loop, DDC — and differ only in setpoints and safety class. The findings of 20.9% ineffective, eleven root faults, and sensor faults leading can therefore serve as an **order-of-magnitude analogue** for laboratory terminals. When citing, state explicitly that these are analogous equipment, not laboratory measurements.

4.3 Classic fault-type distributions

Study	Sample	Finding
Stouppe & Lau (1989)	15,760 failure records (insurance claims, 1980–1987)	Electrical **76.6%**, mechanical 18.9%, refrigerant circuit 4.5%
Breuker & Braun (1998)	c. 6,000 service records	Electrical or control **60%**, mechanical 40%; compressor failures infrequent but the costliest to repair
Cowan (2004)	503 units / 181 sites / 5 states	Improper refrigerant charge 46%, economizer faults 64%, airflow problems 42%, thermostat faults 58%, sensor faults 20%

05 Open fault datasets you can actually download

If the report needs real fault time series for worked examples or algorithm validation, these are obtainable.

Dataset	Contents	Access
ORNL VAV terminal fault dataset Jung, Yoon & Im, *Scientific Data* 12:763 (2025) Peer-reviewed	Measured in a two-storey test building at Oak Ridge National Laboratory. Two fault types: **VAV damper stuck** (3 test sets) and **discharge airflow sensor bias** (2 sets), each with a fault-free baseline and several fault intensities. **One-minute interval** weather, indoor and VAV data.	DOI `10.1038/s41597-025-05063-z` Open access, data published with the article
LBNL / PNNL HVAC fault prevalence Crowe et al. (2023) Government report	Fault records reported by eight FDD platforms across 317 buildings, harmonised under a common HVAC fault taxonomy. Reports the affected-equipment share for each AHU and ATU fault type.	Public PDF at energy.gov Suitable for citing statistics; contains no raw time series
ASHRAE RP-1312 fault taxonomy Research project	Identifies **31 AHU fault types** — 12 sensor faults and 19 system component faults — the most complete fault taxonomy available for ventilation systems.	Via ASHRAE or papers citing it **Strongly recommended as the basis for any fault tree or checklist**
Granderson fault datasets Peer-reviewed	Covers outdoor-air damper stuck, cooling and heating coil valve stuck and leaking, biased outdoor-air temperature, condenser fouling, setback schedule errors, thermostat errors, filter restriction, fan outlet blockage, VAV damper stuck, reheat valve leakage and VAV airflow sensor bias.	Public datasets, largely simulation-derived Good for algorithm validation, weaker on representativeness

06 Acceptance criteria: standards

The criterion must be stated before any pass/fail claim, or the data cannot be reproduced or compared.

Standard	Key criterion	Note
JGJ 91-2019 Code for design of scientific research buildings National standard (China)	Table 8.3.2 sets three tiers by maximum allowable concentration: · >15 mg/m³ (low toxicity): mean **0.35** / minimum **0.25** m/s · 0.2–15 mg/m³ (toxic or hazardous): mean **0.50** / minimum **0.40** m/s · <0.2 mg/m³ (extremely toxic or low-level radioactive): mean **0.75** / minimum **0.65** m/s	The most cited Chinese criterion. Note it is **not a flat 0.5**; judging every hood against 0.5 m/s is a common error
HG/T 20698-2009 Code for HVAC design in chemical industry Industry standard (China)	Two dimensions — hazard class and availability of make-up air: Harmless but polluting 0.4 / 0.5 m/s; light-to-moderate hazard 0.5 / 0.6 m/s; extreme hazard or low-level radioactive 0.6 / 0.7 m/s Laboratory air changes 6–8 h^{-1}	The same hood has different criteria with and without make-up air. Always state the make-up air condition
AQ/T 4274-2016 Technical specification for capture velocity testing of local exhaust ventilation Industry standard (China)	Hood **capture velocity**: 0.5 m/s for toxic gas, 1.0 m/s for dust	Measurement location differs from "hood face velocity". Mixing the two in one table invalidates the result

Standard	Key criterion	Note
ANSI/ASHRAE 110 Method of testing performance of laboratory fume hoods International standard	Three states — AM (as manufactured) / AI (as installed) / AU (as used). Tracer gas (SF_6) quantifies leakage; the usual acceptance limits come from ANSI Z9.5: AM ≤ 0.05 ppm; AI and AU ≤ 0.10 ppm	**It is a test method, not a pass/fail standard.** Limits must be taken from Z9.5 — a very common citation error
ANSI/AIHA Z9.5 Laboratory ventilation International standard	Face velocity 0.4–0.6 m/s; tracer gas leakage limits; commissioning and periodic verification requirements	Normally cited as the acceptance basis for ASHRAE 110
NSF/ANSI 49 · YY 0569 Biosafety cabinets Standard	HEPA integrity: scan-tested points ≤0.01%, non-scan points ≤0.005%; downflow 0.25–0.50 m/s; noise <67 dB; Class II inflow per cabinet type	Field certification at least annually; re-certification after relocation, filter change or contamination event
GB 50736 · GB 50346 National standard (China)	Air-change rates and biosafety laboratory ventilation requirements	Used together with JGJ 91

One trap worth flagging: JGJ 91-2019 gives three design tiers — 0.35, 0.50 and 0.75 m/s — whereas most inspection reports simply write "0.4–0.6 m/s passes". These are not the same thing: the former is a tiered design value, the latter a commonly used acceptance band. A report should state in its methods which criterion it applied and under which clause, otherwise the data is neither reproducible nor comparable.

07 Annotated source list

Ordered by credibility, highest first. All links were accessible at the time of compilation.

[1] **Pasanen T., Kalliokoski P., Kokotti H. Performance of Laboratory Fume Hoods.** University of Kuopio, Finland · AIVC / Indoor Air conference paper · Peer-reviewed
aivc.org/sites/default/files/airbase_13553.pdf
Citable data: 295 hoods measured. Face velocity compliant 27%, exhaust flow 22%, turbulence 5%, all criteria 2.7%. Root causes include jammed dampers, debris in ductwork and misplaced supply diffusers.

[2] **Evaluation of laboratory fume-hoods performance in a petrochemical industry based on ASHRAE 110 Standard.** Iran · journal article · Peer-reviewed
magiran.com/paper/644419
Citable data: 22 hoods. Face velocity compliant 9.09%, SF_6 tracer gas 4.5%. The two results were uncorrelated; face velocity cannot stand alone as a criterion.

[3] **Jacobs P.J. Laboratory fume hood performance.** University of the Witwatersrand · MSc thesis · 2009 · Thesis
wiredspace.wits.ac.za/handle/10539/5966
Citable data: 49 hoods over 11 months. 82% outside standard (70% with excessive flow). Out-of-service rate rose from 14% to 27%, peaking at 47%.

[4] **Safety performance testing and evaluation of Class II biosafety cabinets in a hospital.** *Chinese Journal of Disinfection*, 2024(9) · Peer-reviewed
manu63.magtech.com.cn/zgxdx/CN/10.11726/j.issn.1001-7658.2024.09.003
Citable data: 18 cabinets, overall pass rate 44.44% (A2 50%, B2 40%). Inflow HEPA, UV and cleanliness passed at 100%.

[5] **Ma W. et al. Performance testing and analysis of Class II biosafety cabinets in veterinary institutions.** *Laboratory Animal and Comparative Medicine*, 2022, 42(2):111-116 · Peer-reviewed
slarc.org.cn/dwyx/EN/article/downloadArticleFile.do?attachType=PDF&id=4875
Citable data: 126 cabinets, overall pass rate 17.5%; inflow velocity passed in only 49.2%, noise in 22.2%.

[6] **Qin J., Wang S. A fault detection and diagnosis strategy for VAV air distribution system.** The Hong Kong Polytechnic University · PhD thesis, including a site survey of 1,251 VAV terminals · Thesis
ira.lib.polyu.edu.hk/handle/10397/86969
Citable data: 1,251 pressure-independent VAV terminals, 20.9% ineffective, eleven root faults identified; zone temperature sensor error and local DDC error most common. **This is the original source behind most "20.9%" citations.**

[7] **Crowe E. et al. How Faulty are Commercial Buildings? HVAC Fault Prevalence Study Results.** LBNL / PNNL · US DOE Building Technologies Office peer review, 2023 · Government report
energy.gov/sites/default/files/2023-05/bto-peer-2023-fault-prevalence-lbnl-crowe.pdf
Citable data: 317 buildings, 33,660 AHUs, 153,865 ATUs. 40% of AHUs and 30% of ATUs carry at least one fault on any given day; supply-air temperature sensor faults affect 55% of AHUs, zone temperature sensor faults 46% of ATUs.

[8] **Jung S., Yoon Y., Im P. Datasets of Faults in Variable Air Volume Terminal Units in a Multi-Zone Commercial Building.** *Scientific Data*, 2025, 12:763 · DOI 10.1038/s41597-025-05063-z · Peer-reviewed + open data
nature.com/articles/s41597-025-05063-z
Citable data: Field-measured VAV damper-stuck and airflow-sensor-bias datasets at one-minute resolution, with fault-free baselines.

[9] **Analysis of Automated Fault Detection and Diagnostics Records as an Indicator of HVAC Fault Prevalence.** LBNL technical report · Government report
eta-publications.lbl.gov/sites/default/files/analysis_of_automated_fault_detection_and_diagnostics_records.pdf
Value: Systematically reviews more than a dozen fault-frequency studies (Stouppe & Lau, Breuker & Braun, Cowan, Yoshida, Qin & Wang and others) with their samples and conclusions. **A ready-made secondary source for a literature review.**

[10] **Ebrahimifakhar A. Investigation of the Prevalence of Faults in the HVAC Systems of Commercial Buildings.** University of Nebraska–Lincoln · PhD thesis · Thesis
digitalcommons.unl.edu/context/archengdiss/article/1072/viewcontent/PhD_Thesis_Amir_Ebrahimifakhar.pdf
Value: A critical methodological review of fault-prevalence studies, giving sample size, time span and limitations for each. Ideal support for the argument that existing data are not comparable.

[11] **Fault detection and diagnosis for multiple faults of VAV terminals using self-adaptive model and layered random forest.** *Building and Environment*, 2021, 193:107667 · Peer-reviewed
sciencedirect.com/science/article/pii/S0360132321000780
Citable data: Validated on real VAV operating data with 13 single-fault and 6 simultaneous-fault cases, demonstrating that concurrent faults are the field norm.

[12] **Xiao F. et al. Diagnostic Bayesian network based FDD strategy for VAV terminals.** Journal article · Peer-reviewed
isiarticles.com/article/29302
Citable data: Fault prior probabilities — **temperature sensor fault 25.3%, damper actuator failure 3.8%** — with the argument that sensor faults are far more likely than actuator faults.

[13] **Consensus-Based Method for Anomaly Detection in VAV Units.** *Energies*, 2019, 12(3):468 · Peer-reviewed
mdpi.com/1996-1073/12/3/468
Value: Training-free anomaly detection that exploits consensus across similar units — relevant where a laboratory has many terminals and no historical baseline.

[14] **Comparative study of occupational hazard ventilation technology and standards for chemical and chemical engineering laboratories.** *Occupational Health and Emergency Rescue*, 2025 · DOI 10.16369/j.oher.issn.1007-1326.2025.250363 · Peer-reviewed
oher.com.cn/article/doi/10.16369/j.oher.issn.1007-1326.2025.250363
Value: One of the few Chinese sources to compare standards side by side, itemising the differences and gaps between JGJ 91-2019 and HG/T 20698-2009 on face velocity, air-change rate, pressure differential and air distribution. **The best Chinese citation for the "criteria are not harmonised" argument.**

[15] **JGJ 91-2019, Code for design of scientific research buildings, clause 8.3.2.** National standard (China)
sys.njtech.edu.cn/__local/3/D3/24/BD9C8F28D6BC4BD5D3D7885C13E_4E6A91F8_14DFE16.pdf
Citable data: The three-tier face velocity table (0.35/0.25, 0.50/0.40, 0.75/0.65 m/s).

[16] **Using the ASHRAE 110 Test as a TQM Tool to Improve Laboratory Fume Hood Performance.** SafeLab · conference technical paper · Industry
safelab.com/FACT_SHEETS/TQMPAPER.pdf
Citable data: Based on several thousand ASHRAE 110 tests — **of hoods with face velocity in the 80–120 fpm band, 30–50% exceeded the ANSI Z9.5 leakage guideline**.

[17] **The Myth of Face Velocity Reloaded.** NEBB (National Environmental Balancing Bureau) · Industry
nebb.org/?p=13135
Citable data: More than 80% of hoods failing tracer gas had compliant face velocity; failure attribution 50% room conditions / 25% hood design and layout / 25% user practice.

[18] **ASHRAE 110 Fume Hood Testing: What It Requires and How It's Performed.** Aero Performance Group · Industry
insights.aeropg.com/insights/ashrae-110-fume-hood-testing-what-it-requires-and-how-its-performed

Citable data: Industry estimate of 15–30% hood failure during routine testing; a clear AM/AI/AU comparison table, useful for a methods chapter.

[19] **Laboratory HVAC Maintenance: Fume Hoods, BSCs, and Critical Ventilation Systems.** Oxmaint · Marketing
oxmaint.ai/industries/hvac/laboratory-hvac-maintenance-fume-hoods-critical-ventilation

Reference only: Claims that 40% of hoods fail containment testing when face velocity falls outside 80–120 fpm; includes a useful certification-interval table. **Figures are unsourced; treat as order of magnitude.**

[20] **VAV commissioning pitfalls: why face velocity never settles / Negative-pressure failure in biosafety laboratories: tracing airflow and differential pressure.** Wuchenshi (industry technical blog) · Marketing
wuchenshi.com/lab-knowledge/3183 | wuchenshi.com/lab-knowledge/3208.html

Reference only: Exceptionally concrete field descriptions of sensor–algorithm–actuator mismatch (a sensor mounted in an eddy zone driving the damper to swing between 0.3 and 0.7 m/s; under-torque actuators; a static-pressure sensor too close to an elbow). **Use as qualitative mechanism material, not as a source of figures.**

[21] **2026 summer laboratory ventilation inspection reports (research laboratories; school of pharmacy).** User uploads on book118 document-sharing platform · Unverifiable provenance
max.book118.com/html/2026/0623/7141034132011124.shtm

Data shape: 726 fume hoods at 92.7% compliance, universal exhaust hoods 78.4%, atomic absorption hoods 95.2%, biosafety cabinets 97.8%, exhaust systems 93.1%, room negative pressure 89.3%; includes details such as a 72-hour average detection lag.
⚠️ **Strong recommendation:** these documents have **no author, no institution and no primary record**, and their figures are suspiciously tidy, indicating template-generated text. **Do not cite them as sources.** Their value is limited to the inspection framework — test items, criteria, defect categories — which is well designed and can inform your own protocol.

08 Where to search next

The 21 entries above are a starting point. These routes are the most productive for going deeper.

8.1 Chinese databases (CNKI, Wanfang, VIP)

Search on *fume hood* + *face velocity* + *testing* rather than *laboratory ventilation* + *fault*; the latter returns mostly HVAC design articles with a low hit rate. Suggested queries:

- `通风柜 AND (面风速 OR 控制风速) AND (检测 OR 测试 OR 验收)`
- `生物安全柜 AND (性能检测 OR 现场检测) AND 合格率`
- `实验室 AND (变风量 OR VAV) AND (故障 OR 调试 OR 自控)`
- `局部排风 AND (失效 OR 排风效果) AND 实验室`
- `实验室通风 AND 能耗 AND 运行数据` — for retrofit studies with measured data

Most productive journals: *Heating Ventilating & Air Conditioning*, *Building Science*, *Chinese Journal of Disinfection*, *Occupational Health and Emergency Rescue*, *Laboratory Animal and Comparative Medicine*, *Research and Exploration in Laboratory*.

8.2 English databases (Web of Science, Scopus, Google Scholar)

- `"fume hood" AND ("face velocity" OR containment) AND (survey OR "field study" OR commissioning)`
- `"laboratory ventilation" AND ("fault detection" OR "fault diagnosis" OR "performance degradation")`
- `"VAV terminal" AND ("fault prevalence" OR "site survey" OR "root fault")`
- `"biosafety cabinet" AND certification AND ("failure rate" OR nonconformance)`

Key authors and groups: **Wang Shengwei** (PolyU Hong Kong) — foundational work on VAV terminal FDD; **Crowe and Granderson** (LBNL) — fault prevalence; **Im Piljae** (ORNL) — open fault datasets.

8.3 Grey literature — often closer to real fault data than journal papers

- **AIVC** (Air Infiltration and Ventilation Centre), `aivc.org` — a large free conference-paper library with a high hit rate for laboratory ventilation.

- **ASHRAE Transactions and ASHRAE research project (RP-) reports** — the primary source for fault taxonomies and field surveys.
- **NIOSH and UK HSE** — LEV examination reports and incident investigations, including real failure cases.
- **Chinese university laboratory safety inspection notices and Ministry of Education on-site inspection feedback** — the domestic data closest to reality, usually not published in detail and obtainable only through institutional channels.
- **Public case libraries from CMA/CNAS-accredited testing bodies** — consistent measurement basis, useful as a methodological reference.

09 Notes for writing the report

Five practices that materially raise the credibility of an inspection report.

9.1 Never mix face velocity with capture velocity

Face velocity (mean velocity across the working opening, JGJ 91) and capture velocity (AQ/T 4274, measured near the source) are different physical quantities with different criteria. Presenting both in one table as a single "compliance rate" is a substantive error.

9.2 Every compliance rate must carry its criterion and sample size

The same batch of hoods may show 90% compliance against the 0.35/0.25 m/s tier and only 60% against 0.50/0.40. Fix four columns in every data table: **sample size / source of criterion / pass rule (mean or single-point minimum) / result**.

9.3 Prefer "non-compliance rate" over "failure rate"

Inspection studies report the proportion non-compliant at a point in time; FDD studies report fault frequency over an operating period. The first is cross-sectional, the second longitudinal. Writing "failure rate 20.9%" without stating that this refers to VAV terminals rather than fume hoods will invite a charge of equivocation.

9.4 When figures conflict, weight by sample size and methodological transparency

Reported hood non-compliance ranges from 9% to 91%. The spread comes from criterion stringency, equipment age and whether tracer gas was included. Rather than averaging, **treat the spread itself as the finding** — "existing inspection data are highly dispersed, and the root cause is the absence of a harmonised criterion and test state" is a stronger and more defensible conclusion than a synthetic mean.

9.5 Exclude unverifiable sources explicitly

The "inspection report" texts circulating on document-sharing platforms are highly templated and contain figures of suspicious precision ("726 hoods, 92.7%") with no primary record. **Borrow the framework, not the data.** If a reviewer asks for the underlying record and none can be produced, the credibility of the entire report is compromised.

> **A finding that can go straight into the discussion chapter:** the three most rigorous field studies in this field — 295 hoods in Finland, 49 in South Africa, 22 in Iran — all converge on the same conclusion: **there is a systematic gap between "compliant face velocity" and "actual containment capability".** In the Finnish study, 27% of hoods met the face velocity criterion but only 2.7% met every criterion. NEBB's data show that 80% of hoods failing tracer gas had compliant face velocity. An inspection regime that uses face velocity as its sole criterion therefore systematically overestimates the real safety level of a laboratory. This is the central argument missing from most existing Chinese inspection reports.

Scope and method. Compiled from public web sources on 18 October 2026. All figures are quoted from the sources listed and have not been recalculated; where figures are compared across studies, differences in measurement basis are noted. Industry and marketing sources are included as leads only — formal citation should return to the primary document.

Suggested next steps. (1) Obtain full texts of entries 6, 11 and 14 through an institutional library. (2) If real fault time series are needed for worked examples, download the ORNL dataset in entry 8 first. (3) If domestic measured data are required, adopt the test protocol from entries 1 and 2 and run a small primary survey rather than citing inspection reports of unknown provenance.