Supporting practical science, D&T and art

- in schools and colleges

Fume cupboard buying guide

Feature	Fume cupboard with duct	Re-circulatory filtration fume cupboard
Air flow	Minimum **face velocity** 0.3 m s^{-1}, at sash height 400 mm (ideally about 0.4 to 0.45 m s^{-1}). Should not vary too much across the opening. To prevent the face velocity increasing by too much when the sash is lowered, cupboards should have a by-pass or a variable air volume system (VAV). The latter is more energy-efficient.	
Services: **gas, electricity, water and waste**	Fixed services are easy to provide, with service pipes and cables well protected. If flexible ducting is used to provide a degree of mobility, it requires a docking point (see right).	Docking point (special service connection) required. Length of flexible gas piping (max 1.4 m) limits movement.
	Controls should be outside the cupboard and not operated by rods.	
Necessity and suitability for school chemicals	Fume cupboards protect employees and students from hazardous chemicals. Without a fume cupboard the National Curricula and most exam specifications cannot be delivered fully.	
	Any chemicals likely to be used (but not chlorine gas cylinders).	Not suitable for processes producing sparks. An educational filter copes with most chemicals except hydrogen, methane, carbon monoxide and mercury.
Glazing	Toughened glass > 5 mm thick, acrylic or polycarbonate. Transparent for ease of viewing.	
Noise level	< 50 dB(A) measured at 1500 mm above the floor and 1500 mm from the face of the fume cupboard, with the sash set at 200 mm allows the teacher to talk to a class without shouting whilst cupboard is working.	
Sash stops	Should be a stop at 400 mm which can be over-ridden for cleaning, and one at 50 mm to prevent fume cupboard closing completely.	
Work surface	Depression or lip needed to prevent spills from dripping onto the floor or user.	
Mobility	A class cannot easily see what is happening in a fixed fume cupboard. Limited mobility allows the teacher to be on one side, with pupils on the other three sides. With full mobility the cupboard can be moved around the lab or from lab to lab. However limited technician time means that fume cupboards are very rarely moved. Consider: How easy is it to disconnect and push around the laboratory? Are there cart handles to aid movement? Will the cupboard fit through the lab doorways? Airflow may be affected by where cupboard is located in the room, in relation to ventilation or air conditioning ducts. This can be allowed for when commissioning a fixed fume cupboard.	
	Ducted fume cupboards are rarely mobile.	Filtration fume cupboards are usually mobile.
Visibility for pupils	Poor, unless placed in the centre of a long wall and has transparent sides. Can provide 360° visibility if fitted with a flexible duct.	360° visibility if sited correctly and has transparent back and sides.
Installation and commissioning	Should be part of the buying process and costs. Fume cupboard supplier (not necessarily the same as the fan and ductwork installer) should commission it, ideally in presence of science teachers and technicians.	
Number required	At least two in any lab used for A-level chemistry (one suitable for demos), three if classes > 15. One suitable for demonstrations in a third of labs used for work up to GCSE. Whilst in principle a mobile one would allow a school to cope with fewer, in practice limited technician time means that they are rarely moved. Prep rooms need one **ducted** fume cupboard at least 1 m wide, preferably up to 1.5 m wide, if space permits. Filtered units would only be acceptable in very few situations.	
Costs	Initial installation costs high because of the need for a duct venting at roof level (which may need planning permission). Running costs negligible. Will last for many years.	Less robust, fan motors can need replacement after some years. Filters (and pre-filters) will need replacing periodically. Typically £600 or more + possible disposal costs. See *Explanatory notes*. Technician time if cupboards are moved.
Testing	Every year (strictly, every 14 months). A simple airflow test, well within the capabilities of a school technician.	Every year (strictly, every 14 months). A filter test will be required, increasing the complexity and cost, unless filters are replaced regularly which may result in disposal of still usable filters.

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Feature	Explanatory notes
For further guidance and information about training refer to the CLEAPSS website: http://science.cleapss.org.uk/ Fume cupboards are discussed in para 5.7.3 of *Building Bulletin 101: Guidelines on ventilation, thermal comfort, and indoor air quality in schools* from the Education and Skills Funding Agency (2018) (https://www.gov.uk/government/publications/building-bulletin-101-ventilation-for-school-buildings).	
Design	**All** fume cupboards in schools should meet the design requirements in CLEAPSS Guide G9 and/or the appropriate BS/EN standard. There are two main types of fume cupboard. **Ducted fume cupboard**: hazardous gases are mixed with air and vented into the atmosphere via a duct (chimney) to the roof with the fan on the roof, in the roof space, or on the outside wall near the roof. This should be to design standard EN 14175. Ducted fume cupboards can be mobile or semi-mobile (with flexible ducting). **Recirculatory filtration fume cupboard**: pulls the air through a filter which removes most (but not all) of the hazardous gases and then discharges the air back into the room. There may be some odours even if the cupboard is working correctly. This should be to design standard BS 7989:2001.
Air flow	**High face velocities** can be dangerous and unsuitable. Velocities greater than 0.6 m s^{-1} could destabilise or extinguish a Bunsen burner flame, the fan may be noisy and energy is wasted. A **built-in air-flow indicator** is now required for new cupboards and shows the cupboard is operating correctly. Face velocity should not increase by more than about 50% when the sash is lowered from 400 to 200 mm. In the past, most school fume cupboards have had a **Constant Air Volume** (CAV). When the sash is lowered, the same volume of air is pulled through a smaller opening and hence its velocity increases. Since the 1990s, most school fume cupboards have had a by-pass so that the increase in face velocity is not too great. However, the fan is running at the same speed and thus wastes energy. The improvement in electronic control in recent years has led to the introduction of **Variable Air Volume** (VAV) fume cupboards, which automatically reduce the fan speed as the sash is lowered, hence no by-pass is needed.
Sustainability	**Ducted fume cupboards** discharge hazardous fumes to the atmosphere, where they are massively diluted and in any case quantities discharged by schools are very tiny. **Recirculatory filtration fume cupboards** use filters and pre-filters which will need disposal, normally via land fill. **Both types of fume cupboard** can have either a by-pass or a variable air volume system to prevent the face velocity increasing by too much when the sash is lowered. A by-pass wastes energy and so VAV fume cupboards are much more sustainable and will be preferred especially in new builds where the total energy use of the building is an important design consideration if BREEAM certification is required.
Noise level	In the past, some fume cupboards have been very noisy which can make it difficult for a teacher (or pupil) to be heard. The Education and Skills Funding Agency now offers guidance in *Building Bulletin 93: acoustic design of schools - performance standards* (2015), see para 1.1.3, Note 3 (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/400784/BB93_February_2015.pdf) (see *Noise levels* on previous page).
Services	Prep room fume cupboard should have a large **sink**. A **sink** or **drip cup** is adequate in teaching labs. Some drip-cups are too small, but larger cups and sinks reduce working space. **Gas, water and drainage** connection fittings for mobile or semi-mobile cupboards are best installed at or close to floor level when laboratory refurbishment takes place.
Waste liquid disposal	**Hazardous chemicals** must be well diluted before entering the waste. **Waste** may remain in traps for some time, especially in rarely-used fume cupboards. Waste may be corrosive or contain an organic solvent (but should not). This can damage the piping and, over time, cause leaks. Chemically resistant polypropylene, eg Vulcathene, is satisfactory. A **docking station** must be lower than the waste outlet on the cupboard.

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Filters and pre-filters	**Pre-filters** may need changing every 6 to 12 months, depending on use. Replacement is easy. Pre-filters may be made of compressed paper, but this may ignite from sparks produced in chemical reactions (eg 'the howling jelly baby') so filter fume cupboards are unsuitable for these types of reactions. **Damaged seals** around the filter cause leakage of hazardous gases. If the heavy filter is below the fume cupboard base, ideally in a drawer or similar device, it can be changed with least risk of damage to the seal but better capture of fumes is achieved with high level filters. **Filters** can be tested for saturation every year to see if replacement is necessary or they can be replaced regularly. CLEAPSS evidence from schools suggests this should be at least: • every 4 years for laboratory fume cupboards, or 3 years with heavy use; • every 1-2 years for prep room fume cupboards. More frequent testing or replacement may be necessary if there are unexpected odours or other issues. Initial savings in buying a filter fume cupboard are often be negated by the cost of replacement filters and/or the cost of testing filters. It is advisable for new filters to be put in by the installer/contractor as they are heavy and it is easy to damage the seal. They should be tested immediately for leakage in case the seal has been damaged. Used filters must be disposed of. It is questionable whether they count as hazardous waste because there is a relatively small amount of hazardous chemicals in a large mass of low hazard carbon. If the spent filter is regarded as hazardous, it would need to be bagged, labelled, and removed by a registered waste contractor. Cost of this disposal should be considered when comparing ducted vs. filtered fume cupboards.
Work surface	Suitable work surface materials include filled acrylics, solid epoxy, moulded glass-reinforced epoxy laminate, suitably-grouted ceramic tiles, or grade 316 stainless steel. Melamine-surfaced phenolic resins are severely marked by red-hot objects. Light colours quickly get disfigured by the inevitable spills.
Mobility	Filter fume cupboards are almost invariably mobile. Some ducted fume cupboards are on a trolley and connected through a flexible duct to a fixed ventilation duct; services are provided through flexible lines (hoses and cables). It may be possible to disconnect the flexible ventilation duct and other service lines and move the fume cupboard to other places with suitable connections (docking stations). The waste water hose may be contaminated with hazardous substances. Despite claims that a mobile fume cupboard allows you to provide only one cupboard which can be moved from room to room, in practice schools very rarely move mobile cupboards from lab to lab because they are heavy and awkward to move and technician time is limited.
Commissioning	Commissioning shows that the fume cupboard as installed performs according to specification/ requirements, and provides a benchmark against which future performance is judged. The technician and/or senior chemistry teacher should be present at the commissioning. As part of the contract, training should be provided. Commissioning should be recorded in the Log Book, as should results of later tests and maintenance.
Testing	The *COSHH Regulations* require that fume cupboards are tested at least every 14 months. This can be done by an insurance company representative, appointed testing companies, or by the technician or teacher if that person has been trained and is deemed competent by the employer. (CLEAPSS offers such training). Companies' charges may depend on how far the school is from their base, the number of cupboards and whether filter testing is carried out. Tests include a visible inspection of the fabric and connections in the fume cupboard, and an air flow test. An anemometer reading to 2 decimal places at speeds from 0.1 to 0.3 m s^{-1} can be costly (probably about £500 including VAT) but could be shared with neighbouring schools. The test is well within the competence of most school technicians. The cost of testing filter fume cupboards can be double that of ducted fume cupboards. If filter efficiency is tested 97-99% efficiency is required (depending on the gas). This increased cost should be considered when comparing ducted vs. filtered fume cupboards.

See *Technical Notes* on the following page.

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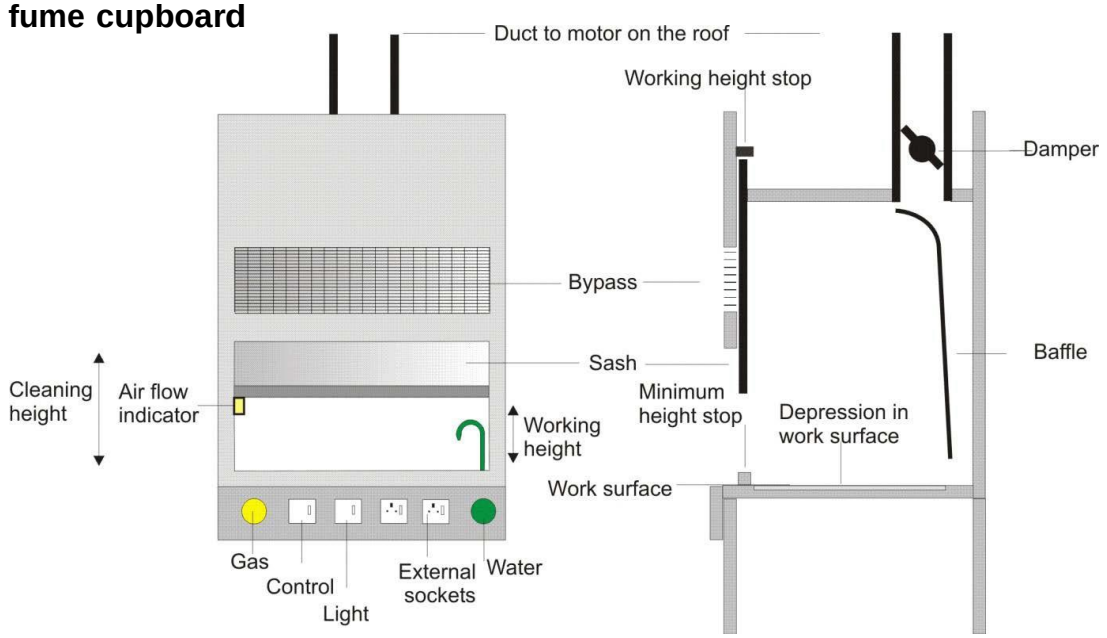
Ducted fume cupboard

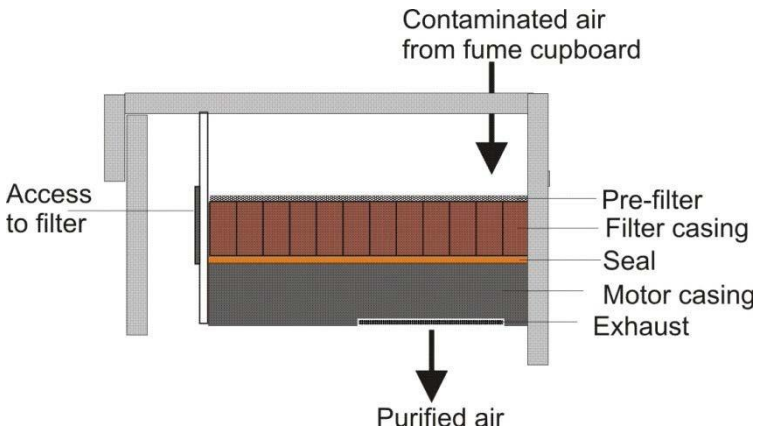


The **damper** is used when the fume cupboard is installed and commissioned to adjust the airflow to give a suitable face velocity. It should then be locked in position.

A **bypass** prevents the face velocity increasing by more than the recommended amount when the sash is lowered. Modern fume cupboards may alternatively have a variable air volume (**VAV**) system which is more energy efficient because sensors automatically reduce the fan speed if the sash is lowered.

The **baffle** helps to achieve an even face velocity across the sash opening.

Filters



Carbon filters absorb organic vapours; in school they also need to absorb toxic and corrosive inorganic chemicals such as chlorine, sulfur dioxide, and ammonia. This is achieved by doping the carbon with, for example, sodium hydroxide to absorb acid gases, and phosphoric acid to absorb alkaline gases. Schools must ensure that educational filters are specified both initially and in subsequent replacement.

A **pre-filter** is used to prevent the filter clogging up with dust and smoke particles.

No filter is 100% efficient, so some chemicals leak through. As absorption sites on the filter material are used up, more chemicals will leak through. The human nose can be quite sensitive to some (but not all) odours, so detection of odour does not necessarily mean the filter is not working; equally, an inability to detect odours does not mean it is working satisfactorily. Usually odours are detectable below the Workplace Exposure Limit for that chemical. However, if odours are increasingly detected, this should be taken as a warning and saturation tests carried out or the filter replaced.

GATSBY

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