



Science Labs in Secondary Schools

Recommended Science Lab standards for architects and designers



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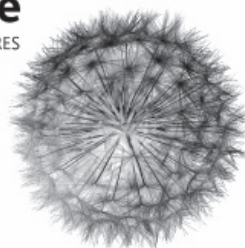
Science Labs in Secondary Schools

*A Special Report to good Science Lab standards
for architects and designers*

Published by Gratnells Ltd.

Prepared originally for Science Learning Centres by Andy Piggott, Independent Science Education Consultant specialising in lab design and science health and safety.

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LEARNING CENTRES



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‘School science laboratories are an expensive investment and are expected to last for many years. A poor design will impact on generations of pupils, teachers and technicians.’

– The Association for Science Education

***Project Faraday, Exemplar designs in science**, 2008, DCFS

Introduction

This Special Report is intended for architects and specifiers and looks at the issues that need to be discussed regarding the design and construction of science accommodation and the installation of furniture, services and equipment. The contents are applicable to England and Wales; different pupil numbers and provisions apply in Scotland and N. Ireland.

When designing science accommodation, even a single laboratory, the aim is to provide attractive, well-equipped facilities that support pupils as they engage with and learn about science. Exciting, high-quality practical work is a vital part of pupils’ science experience and provision for this is what makes science accommodation unique. However, ambitions for high standards of science accommodation are often thwarted, to a greater or lesser extent, by constraints such as a lack of:

- Knowledge about what the facilities might look like.
- Flexibility to create the optimum size and shape of rooms within an existing building.
- Budget – planned or unplanned – with costs overrunning.
- Knowledge about the essentials required for health and safety.

The extent to which a school will want or need to compromise on its ambition is not easy to define. However, this Special Report describes what can be achieved without compromises. The nearer the final build is to descriptions in the following pages, the longer the design will last while still providing high quality facilities. If features are input at the design stage, most will cost very little or nothing at all. Correcting mistakes retrospectively, on mandatory health and safety features for example, can be very costly. In order to maintain good standards within laboratories, a range of support spaces are essential. This Special Report will also look at some of the standards required for these support areas.

As *Project Faraday** (see Page 24) has clearly demonstrated, teachers, technicians, support staff and pupils should be involved throughout all the stages of design and build. This requires time, resources and support for staff going through possible changes in teaching practice, changes in types and styles of accommodation, and the stress of coping with building works.

‘Only equipment in frequent use should be stored in a laboratory; all other equipment and materials should have dedicated storage.’

The Science Laboratory

This is a serviced, practical area for the teaching and learning of science. Other functions are better catered for in adjacent support and storage areas (see below)

The chemicals, materials, equipment and services involved in science laboratories make them a ‘danger area’ under health and safety regulations. It is therefore essential that they are supervised by suitably qualified staff, are properly equipped for health and safety, and are not used for inappropriate activities. The same considerations apply to the Prep Room, the chemicals store, the radioactives store and some equipment stores.

Only equipment in frequent use should be stored in a laboratory; all other equipment and materials should have dedicated storage. Teachers’ marking and personal preparation are best provided for away from the laboratory. Most management activities are best accommodated in planned spaces, while social activities, eating and drinking should certainly be accommodated separately from the ‘danger areas’. A laboratory is not the most suitable place for a tutor-base.

Other learning spaces

The usual science accommodation has been all laboratories, each fully fitted out. This is the most flexible provision in terms of traditional curriculum models, schools’ timetables and management systems. If a school’s vision for its pupils’ learning looks forward to alternative types of spaces to complement laboratories, there must be corresponding shifts in management of staff, the curriculum, timetabling, organisation of pupil groups, and the timings and scheduling of the school day.

Such spaces might include group or individual learning areas, ICT areas, demonstration theatres, microbiology (clean) areas, environmental areas, greenhouses, etc. Project Faraday provides an excellent range of examples. The majority of spaces will need to be supplied with services to allow a wide range of practical work to be carried out.

Support areas

‘All stores should be easily accessible from the Prep Room(s) and the laboratories.’

Prep Room(s)

The purpose of these areas is to support the practical work taking place in laboratories. They are for the preparation, maintenance and repair of equipment and materials and for the disposal of materials when they are finished with. As such, they are for the use of science technicians (and science teachers who are preparing or practising practical activities) with administration facilities focused on the support of practical work. Other management and administrative functions, social and refreshment activities, should be catered for in other spaces.

Stores

- **Chemicals:** A separate, secure storeroom for hazardous chemicals is essential. It should open into the Prep Room and be separately ventilated.
- **Radioactives:** Radioactive sources must be stored in a metal cupboard within a secure storeroom. This storeroom is usually one used mainly for general equipment or paper resources.
- **Other storerooms:** These will be needed for gas cylinders, general equipment, paper, textbooks, ICT equipment, etc. Most of these will need to be secure as a protection from theft or damage. Some equipment (eg vacuum glassware, high voltage equipment) will also need additional security for health and safety reasons.

All stores should be easily accessible from the Prep Room(s) and the laboratories.

Management, administration and individual staff work spaces

Proper provision for these functions will promote higher standards of leadership and morale. It will also ensure that the laboratories and Prep Room(s) are able to function safely as practical areas.

Social and Refreshment

Newer designs for schools include distributed provision for social and refreshment areas for staff; sometimes also for pupils. These areas may be specially designed, separate areas, or part of the management/administration areas. It is better to plan and design these as part of the vision for the science area, rather than let them grow up within the science department as they will inevitably do.

Toilets

Staff are entitled to toilet provision within easy reach of their teaching areas. Distributed provision for pupils is an increasing trend and can mean that pupils take better care of the facilities. Toilets for the disabled should also be easily accessible from science areas.

Cleaning equipment

Storage of cleaning equipment should be entirely separate to science accommodation, including science stores.

References:

National Guidance on Lab Design, available at:

www.ase.org.uk/resources/lab-design

Science Accommodation in Secondary Schools, Building Bulletin 80, 2004, DCSF.

Designing and Planning Laboratories, G14, 2009, CLEAPSS.

A Portfolio of Lab Designs, 2010, A. Piggott.

See Appendix for other references.

‘Last year we had four labs refurbished.... Pods were not adequately fastened to the floor so we soon had gas leaks.... We asked for Grasnells racking but got a cheap substitute with flimsy trays and non-adjustable spacing... Smart boards have been fitted throughout,..in one case the projector was placed to shine directly in to the teacher’s eyes.’
– Royal Society of Chemistry

The Laboratory – Good standards

The standards below refer to a laboratory (a practical work area for science) that provides for up to 30 KS3/ KS4 pupils, or 20 A-level students, along with one wheelchair user and up to two support staff.

Space

A minimum floor area of 90m². Its shape should be rectangular, or close to it, with a length to width ratio of between 1:0.8 to 1:1.1. Circulation spaces are vital. Recommended safe distances are as *Building Bulletin 80*, page 15 (see *Appendix: Safe Distances*), with extra circulation space for wheelchair user and support staff (see *Building Bulletin 102*).

Zones

Zones should contain the following:

- Two (teacher) presentation areas, each on different walls (see *Appendix: TP1, TP2*) – one for demonstration, one with a teacher base (the base and demonstration area could be on the same wall).
- Fume cupboard zone.
- Wall zone for health and safety equipment (see *Appendix: Health and Safety Zone*).
- Display areas.
- Role play areas, with room for pupils to enact drama (where all activities take place in labs).
- Presentation areas to have good sight lines for all pupils. Note that ‘face the front, in straight lines’ does not provide this (see *Appendix: Sight Lines*).

Access / Egress and Security

- **Emergency egress:** This suggests two doors, remote from each other, both directly onto fire escape routes. A door to the Prep Room is also required.
- **Doors:** All doors should be fire doors (≥ 30mins), with view panels and automatic closers (See *Building Bulletin 100*). These should be wide enough and tall enough to permit the passage of large equipment and wheelchairs (See *Building Bulletin 102*). Locks should allow egress without a key (e.g. turnbuckles) and should not be on school-wide master keys.

Lifts

Where science accommodation is on more than one floor, or is not on the ground floor, a passenger lift is required to meet the requirements of the Disability Discrimination Act (DDA). If such a lift is within easy reach of the Prep Room(s), and easily accessible from main thoroughfares, this is also the better solution for manual handling of equipment, etc., between floors. Any lift should be wide enough/tall enough to accommodate wheelchairs and support staff, mobile fume cupboards, etc. Otherwise a special goods hoist between Prep Rooms should be installed. Such hoists should NOT be installed in Science Labs.

Security

Labs should be locked when unoccupied, and supervised by suitably qualified science staff when open.

Furniture and Equipment

There are a number of important issues to consider when planning a good working, ergonomic school science laboratory:



■ Photographs courtesy of S & B UK Ltd, www.splusb.co.uk

- **Pupil benches:** These should have a work surface area $\geq 0.36\text{m}^2$ per pupil, with linear frontage $\geq 600\text{mm}$ per pupil. The height of pupil benches should be 900mm, with good clearance for legs when the pupil is seated at the bench (270mm top of stool to underside of bench) – see *Building Bulletin 80*. All services, except water, should be within 600mm of the pupil position in at least one layout.
- **Perimeter benching:** This should be on two walls maximum, with the height to match pupil benching, and having adequate structure to support it, especially on long stretches.
- **Demonstration bench/service bollard:** This should have all services (e.g., water, gas, electricity), and be the same height as pupil benches, with no teacher dais.
- **Teacher base:** This is a secure storage area for the teacher's laptop and personal items while conducting a science lesson (see *Appendix: Teacher Base*). The base can be part of the demonstration service bollard.
- **Presentation areas:** Writing whiteboards, as well as one/both with projection screen(s) (see *Appendix: TP1 and TP2*).
- **Display areas:** With display boards.
- **Adjustable height bench:** For mobility impaired. Services from an adjacent bench/service bollard (which itself may be need to be adjustable).
- **Service bollards/pedestals, where used:** Heights should match benches, with very secure floor fixings to ensure safety of gas



■ Photographs courtesy of S & B UK Ltd, www.splusb.co.uk

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■ Photograph courtesy of Keystage, www.keystage.com

supplies. The installation should be closely monitored to ensure exact spacing of bollards/pedestals if crucial to designed bench arrangements. (Note: Gas, water and electricity services all on one 600mm x 600mm bollard is acceptable. Also note that the small base area of these bollards can make them unstable).

- **Equipment trolleys:** Again, heights should match benches, with planned spaces for parking and access.
- **Work surfaces:** If Trespa® surfaces are used, these should be $\geq 16\text{mm}$ thick; Corian® materials should be $\geq 13\text{mm}$ thick, bonded to $\geq 25\text{mm}$, moisture-resistant, green MDF subframe. Where bench frames are metal, the grade to be of sufficient thickness and quality to ensure stability and robustness.
- **Cupboards:** Carcasses, shelves, drawer fronts and infill panels should be built with 18mm MDF with melamine facing.
- **Door hinges:** These door hinges should open to $\geq 270^\circ$ and be self-closing.
- **Stools:** Supply one per pupil, plus four spare stools for teacher and support staff. Stool design should include large area leg ends or skids. Allow enough leg space for people to sit at benches (270mm top of stool to underside of bench). Ergonomic considerations should include a back rest if possible. Stools should be stackable to a maximum height of four stools. (Note: thin tubular steel legs with ordinary plastic ferrules will quickly lose their ferrules with resultant holes in the floor – see *Appendix: Stools damaging floor*. Steel ferrules should be ordered with such stools. Cheap stools are a false economy.

Storage

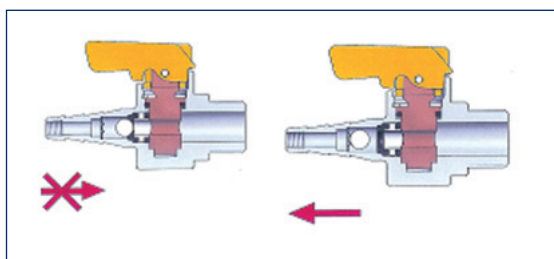
Pupils usually bring a significant number of items such as books, stationery materials and items of clothing into the school science lab. Simply leaving such personal items on workbenches or floors, or draping clothing over the backs of stools can pose serious health and safety risks, and coming into contact with chemicals may well cause irreparable damage. For these reasons, proper storage of pupils' belongings are essential. Additionally, equipment should have its own storage area. Recommendations are:

- **Bags and coats:** Place these near to the main door (but not too near to cause an obstruction). Allow space for each pupil's bag and one coat/bag hook per pupil; two smaller, separated racks leads to less congestion.
- **Ready-use equipment:** Items such as bunsen burners, mats, tripods, etc., may need tray units or cupboards in the lab, generally placed under perimeter benching. All other equipment and materials storage should be in Prep Room(s) shelving or adjacent stores.

Services

Due to limited knowledge of science lab requirements, some new designs have included extensive technological installations (e.g., Internet facilities, large plasma screens, projectors, etc.) but confined bench space, and limited gas and electricity for practical work. It is imperative that provision of services be a main consideration in any school science lab. Recommendations include the following:

- **Pipes and cabling:** These should be installed in or behind benching, walls, or floors. None should be hanging from a ceiling (except for ceiling-mounted data projectors). Pipes should be colour-coded according to contents and show the direction of flow. Pupil services (gas and electricity) outlets should be within 600mm of pupil's work/seating places. Services should be arranged so that pupils do not all face outwards around the walls when undertaking practical work.
- **Gas taps:** *Building Bulletin 80* recommends one gas tap per pupil, spaced around the lab (i.e., ≥ 30). Other taps should be fitted on demonstration benches, perimeter benching and serving the fume cupboard. Do not place gas taps under cupboards, curtains or blinds, or in front of windows. Ensure that all taps are of robust design, with definite on/off positions and anti-rotate fixing to bench, with non-return valves and restrictors in nozzles (see *Appendix: Gas taps*).
- **Gas pipes:** All gas pipes should be concealed if copper (with spaces ventilated) and steel if exposed (*compliant with UP11 Gas Installation Standard*).
- **Electrical Sockets:** *Building Bulletin 80* recommends one electrical socket per pupil (i.e., ≥ 30), spaced around the science lab. As with gas taps, other sockets should be provided for demonstration benches, perimeter benching and the fume cupboard. Electrical sockets should be of robust design, facing away, with shield, if placed near to water. There should be no low voltage systems, instead the use of portable low-voltage supply units should be standard.
- **Electrical circuits:** School science labs usually require at least two 'master' 30 amp ring-main circuits to feed the standard mains sockets. Other, separate circuits not under the 'master' control may be needed for computers, data projectors, fish tanks, fume cupboards. RCDs (Residual Current Devices)/ELCBs



■ Photograph courtesy of Arboles UK Ltd, www.arboles.co.uk



■ Photograph courtesy of Keystage, www.keystage.com

(Earth Leakage Circuit Breakers) should be fitted on each ring circuit (standard 30mA, 30ms specification is acceptable).

- **Water supply:** This should be of high enough pressure to operate science equipment. The supply should be controllable (e.g. with pressure reducer) for emergency eyewashes. To prevent waste water contaminating the incoming water supply, an air gap at the point of entry to lab, usually using a header tank should be provided, with an electric pump to maintain pressure if needed. *Note: Most school science labs should comply with The Water Supply (Water Fittings) Regulations 1999, fluid category 4, concerning fluid which represents a significant health hazard due to the concentration of toxic substances.*
- **Sinks:** *Building Bulletin 80* recommends one sink per 6 pupils (i.e., ≥ 5) spaced around the lab, and each should be large enough for experimental equipment (recommended: $\geq 300\text{mm} \times 200\text{mm} \times \text{depth } 150\text{mm}$) with one cold tap per sink. One larger experimental sink should be fitted on the demonstration bench with two cold taps. A further sink should be included in the fume cupboard. One large sink with drainer on a perimeter bench should be installed for wash up and hand wash, with both hot and cold taps being provided. If a steel sink is fitted, then it should meet grade 316 specifications, not domestic grade 304. A towel dispenser should be provided for hand drying.
- **Water Taps:** These should be of robust design, the top being $\geq 300\text{mm}$ above benches, and with the spout $\geq 225\text{mm}$ above the sink. Tap controls should be located on the front (see *Appendix: Robust tap*). Fixing or locating plates should be used to prevent anti-rotating of the taps. Domestic taps are unsuitable for science labs.
- **Eyewash station:** An eye wash station must be readily accessible within the Science Laboratory. A constant supply of clean, cold water should be available, pressure controlled (often by pipe insert).
- **Drains:** Easily accessible anti-siphon bottle traps should be placed under each sink. Chemically-resistant high-density polythene or polypropylene should be specified for pipe work.
- **Controls:** Gas, electricity and water should all have master controls (emergency shut-offs) in the science lab, easily accessible by teacher, but not by pupils. A gas isolating valve (AECV, *Additional Emergency Control Valve*), inside the room, is mandatory (*UP11 Gas Installation Standards*). Solenoid valves, operated by a central board (see *Appendix: Gasguard*) can obviate the need for awkward pipe runs – they must have their own separate electrical supply. Gas and water should have zoned controls (each service bollard/run) for isolation and maintenance.



Science Lab water tap.



Science Lab bench mounted and wall mounted eyewash station.



■ Photograph courtesy of Keystage, www.keystage.com



■ Photograph courtesy of ALS, www.als-uk-ltd.com

- **Demonstration area (bench or service bollard):** Should have all services, i.e., at least two gas taps and four mains electricity sockets, large experimental sink and all ICT services. Fire and health and safety equipment should be nearby.
- **ICT:** Internet/intranet access for pupils and staff should be provided, along with data projection and accompanying screen. A good quality sound system, linked to ICT, should be installed. For a standard school science lab, ≥ 16 cabled Internet access points plus wireless capability is required, with sufficient bandwidth for all in the vicinity to log on without significant loss in speed. Telephones should be available as part of the school telecommunications system.
- **Fume cupboards:** Should be installed, commissioned and maintained to the guidelines detailed in *Building Bulletin 88* (see also *Building Bulletin 101*). A-level chemistry labs should be supplied with at least two fume cupboards. For demonstrations, supply one for every two laboratories. Fume cupboards should be of the ducted type and not the filter type (see *Guidance on Laboratory Fume Cupboards*, The Royal Society of Chemistry).

Fume cupboards should be sited away from doors and not in a corner; site duct outputs away from other intakes. The duct must rise 1m above roof level (*Building Bulletin 101*). Adequate air supply is required. Extraction should be quiet in operation ($\leq 65\text{dB}$ at 300mm). If the fume cupboards are mobile type, enough docking stations are necessary, with appropriate services incorporated. Hoses should be $\leq 1.4\text{m}$ in length, with the fume cupboard restrained by a stainless steel cable shorter than that. Doors and lifts must be tall enough and wide enough for mobile type fume cupboards to pass through safely.
- **Fire and Health & Safety**

There are number of key fire, health and safety measures to be considered within any school science lab. They include:

- The need for noise, fire, smoke and fumes to be contained. This can be a problem when movable walls are fitted.
- Emergency alarm points should be installed in each science lab or close to them. The alarm system should not emit the same audio warning as the lesson change system.
- An emergency eyewash station should be provided in each science lab that is readily accessible. A constant clean cold water supply, pressure reduced if necessary, is essential (see *Appendix: Emergency Eyewash*).
- Fire extinguishers (2 x CO₂) and fire blanket in each lab; one extinguisher and the blanket to be readily accessible, located by

the demonstration bench. Extinguishers should not be water-based due to substantial electrical circuits and items within the science lab, and preferably not powder-based, which causes severe damage to equipment.

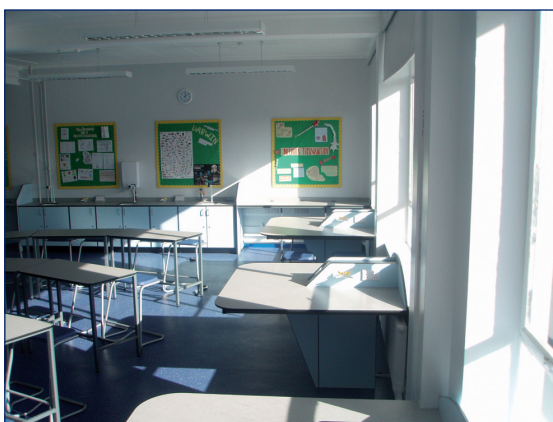
- First Aid kit in each lab, readily accessible.
- Health & Safety zone preferable (see *Appendix: H&S zone*).
- Signs for Health & Safety and Fire to be approved versions only.
- Doors – see *Access/Egress and Security, P9*.
- Sprinkler systems/alarm systems; preferably not fitted, but if so, fit heat sensors only, with trigger temperatures above that which Bunsen burners in science lab use can manage. Additionally, control of the sensor system should be accessible by science staff during any working hours (experiments can easily set alarm systems off).



Environment

Poorly-designed heating, lighting, ventilation, etc., can create significant problems within a school science lab. Apart from considerable health and safety issues resulting from poor environments, teachers and pupils alike may suffer during lessons, resulting in poor learning outcomes. Major environmental issues include:

- Floors to be level, with no ramps. They should also be impervious to water, resistant to chemicals, and non-slip; the manufacturers cleaning instructions/arrangements should be made part of the school's overall cleaning procedures.
- Windows are good for natural light; sills should be $\geq 1100\text{mm}$ from the floor, to allow for benching on/against that wall. Windows should open for ventilation, and be easily accessible. Other than on the ground floor, windows should have restricted openings, which can nevertheless be opened fully in the event of an emergency.
- Solar glare/gain and dim-out for experiments: Use good quality blinds to protect against glare and gain and to provide good dim-out for some experiments. (Note: true blackout is not required in laboratories and, indeed, can be dangerous). Blinds should be light-stop and light coloured (black transmits infra-red and heats up the room).
- Lighting should be $\geq 300\text{lux}$ on work surfaces, plus the provision of task lighting. Zones of light should be individually switchable, especially over whiteboards and projection screens. Energy saving systems should preferably not be fitted – but if they are, they should be controllable by staff during any working hours (it can pose significant health and safety risks to have lights go out in the middle of practical work).



■ Photograph courtesy of Keystage, www.keystage.com



■ Photographs courtesy of S & B UK Ltd, www.splusb.co.uk

- Acoustical specifications: A general noise level of $\leq 40\text{dB}$ with a reverberation time 0.5s-0.8s, plus provision for hearing impaired (see *Building Bulletin 93*). Open plan designs and/or movable walls need particular consideration. Acoustic tiles on the ceiling can be counterproductive as they stop voice projection of teaching staff.
- Heating specifications: Enable a minimum of 18°C , with a maximum of 28°C at any working time. Radiators should not be sited in *TP1* or *TP2* zones (see *Appendix: TP1 and 2*), nor under worktops without adequate airflow (e.g. grids top and bottom).
- Ventilation specifications: There should be ≥ 6 air changes per hour, plus control of humidity. Any forced ventilation should be quiet in operation ($\leq 65\text{dB}$ at 300mm) and utilise an acid and steam resistant fan. Sufficient incoming air for extraction units and fume cupboards is required. Ceilings should be high enough for good ventilation. See also *Windows*. Local control of ventilation is important, especially for microbiology where draughts are a problem. If an air circulation system is used that recycles air, it should not recycle smoke, fumes and smells.
- False ceilings: voids above false ceilings should be checked to ensure firestops are in place (i.e., no gaps in wall construction, round ducting, etc).
- Décor should consist of light, neutral colours in general, with contrasting colours for handles, bench edges, doors and signs. (For vision impaired considerations, see *Building Bulletin B102* and/or *Exploring Access*.)

The Prep Room – good standards

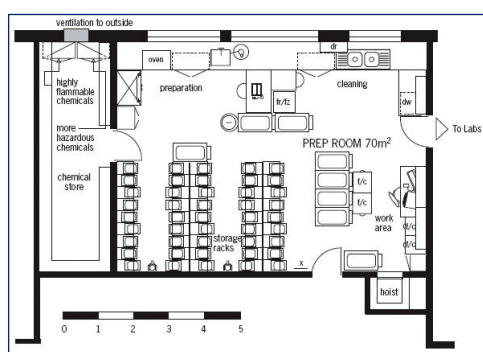
Most of the items that apply to the school science lab also apply to the school science Prep Room. The following section of this Special Report gives an overview of the key aspects of Prep Room good standards in design and planning. For a more comprehensive introduction to Prep Room design for architects and designers, please refer to Part 1 of this *Special Report on School Science Architecture* available from Grathnells upon request.

Position and pace

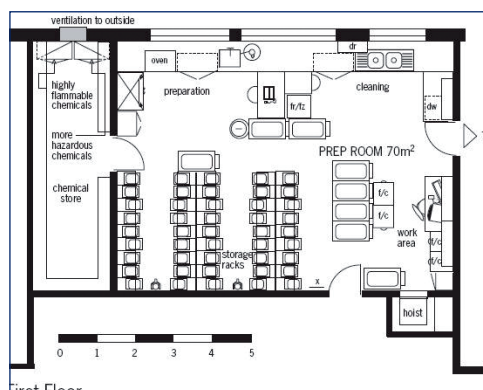
- The Prep Room should be central to the laboratories that it serves. Ideally, it should consist of one large area with stores leading off (the chemicals store in particular). If science accommodation is on more than one floor, then plans should accommodate one Prep Room per floor.
- The recommended floor area for a Prep Room and stores is $\geq 0.5\text{m}^2$ per pupil work space, with other spaces in addition. For example, six labs with 30 pupil places = $180 \times 0.5 = 90\text{m}^2$ (or the size of one science lab). Typical percentages of spaces within this are: *practical work areas: 30%, storage: 30%, mobile storage: 10%, office: 10%, circulation: 20%.*

Access / Egress and Security

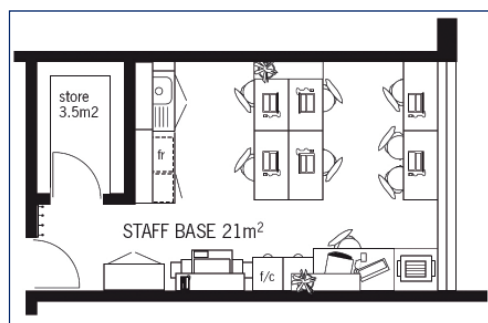
- A large Prep Room needs two doors, with one having an access/egress door direct to the corridor (fire escape) – not through the science lab. A smaller Prep Room would need a risk assessment to see whether more than the one direct access door was needed. Doors should be locked at all times when unoccupied, and supervised by science technicians or science teachers when open. Where a door is in constant use, install two – an 'In' and an 'Out' as in some restaurants.
- For delivery of hazardous materials, an outside door close to, or directly in, the preparation area of the science accommodation should be fitted. This can be shared with the Design Technology (DT) department if science and DT are located next to each other.
- If the Prep Room is not on the ground floor, a lift will be required for manual handling. A specialised hoist between the Prep



■ Preparation on two floors in 7-science lab suite:
First floor.



■ Preparation on two floors in 7-science lab suite:
Second floor.



■ Staff base.

Rooms (NOT in labs) is more expensive and less versatile than an appropriate passenger lift. Such a passenger lift should be within easy reach of the Prep Room(s). (See page 10, *Lifts*.)

Zones

Prep Room work areas should be considered in terms of *zones*. If prep rooms are on different floors, some zones may be prioritised on a floor (e.g., main chemical preparation on one floor along with the chemical store). Standard work zones include:

- **Wet preparation/washing up:** Two large sinks (chemical resistant) plus double drainers, hot and cold tall taps, all with good drainage. An emergency eyewash should be positioned to this preparation area.
- **Chemicals preparation/dispensing:** Sited by the chemicals store (may be one of Prep Room 'wet' areas), plus ducted fume cupboard and good ventilation.
- **Dry preparation/repair and maintenance:** This should include a $\geq 2000\text{mm}$ linear bench, \geq six mains electrical sockets and a metal working vice. Local exhaust ventilation should be fitted if large amounts of soldering will be carried out.
- **Collation/return of equipment:** Floor plans should allocate specific areas for trolleys and free bench areas.
- **Administration:** This is a dry area for the administration of Prep Room activities, away from other preparation zones. This zone should have computer and ICT access, cabinets for filing documents and appropriate shelving.

Storage of hazardous materials

There are three groups of hazardous materials that should be stored separated from each other. Essential details are:

- **Chemicals:** The floor area should be $\geq 10\text{m}^2$, larger for schools with 1000 pupils or more and larger for A-level work. Construction should be fire resistant (60min) and opening directly off the Prep Room, adjacent to the chemicals preparation zone. There should be no direct heating by the sun – i.e., not south, east or west-facing and no flat roof directly above the ceiling. No heating pipes or radiators should be installed, and no holes or voids communicating to surrounding rooms. No drains or windows should be fitted.
 - **Ventilation:** This should provide ≥ 2 air changes per hour (*Building Bulletin 101*), usually by forced extraction with quiet operation ($\leq 65\text{bD}$ at 300mm), at top and

'Designing a science department without a proper chemical store room – or, even worse, without a Prep Room – demonstrates total ignorance of how science departments function. Architects and contractors may turn around and say that store rooms and Prep Rooms were not specified in the contract – but then who drew up the contract, how much expertise and experience did they have in designing school science departments?'

– *Royal Society of Chemistry*

bottom, with auto-control. Sufficient intake air is required for the extraction.

– **Door:** This door should open out into the Prep Room and should contain a view panel, fire stop and lock which opens from inside without a key, for user safety. The door should be locked at all times when not in use, and closely supervised when open. Hazard signs should be clearly visible on the door.

– **Floor:** The Prep Room floor should be impermeable to water, chemical resistant and non-slip. It should slope to the back, or provide a slight hump by the Prep Room door (all this is needed to contain hazardous spills, therefore no drain in floor). The floor should be able to take loading, especially of rolling storage. Stepladders of height equal to shelves should be provided, with grab rails and a stable platform.

– **Fixtures and fittings:** Light fittings should be flame-proof, with metal cabinets provided for flammables. Shelves should be narrow, made from wood with no lips and fitted at $\leq 2\text{m}$ high, stable and secured to the walls. Bund for bulk storage.

- **Radioactive sources:** Guidance on storage of radioactive sources comes from *Managing Ionising Radiations and Radioactive Substances in Schools, etc.*, Guide L93, 2008, CLEAPSS. Radioactive sources must be stored in a secure metal cabinet, fastened to the wall, in a secure general store, at least 2m (ignoring walls, floors and ceilings) from a place where anyone spends extended periods of time. (Not in the chemicals store.)
- **Gas cylinder storage:** These cylinders should be kept in separate secure storage away from flammables (i.e., not in the Chemicals Store) and away from Radioactives. Chained racks or specialist trolleys should be utilised for storing the gas cylinders.

Prep Room furniture

Appropriate furniture should be provided in order that Science Technicians responsible for preparation of science materials and equipment can work efficiently and effectively. Furniture requirements include:

- Benches, $\geq 900\text{mm}$ high, to suit adults, with sufficient clearance underneath for fridges, dishwashers, etc. A measurement of 240-270mm from the top of the stool to the underside of the worktop allows sufficient upper leg clearance for the technician to sit comfortably at the work surface (see *Building Bulletin 80*).
- Stools for benches, with back rests.

- Chairs and Desks for administration.
- Notice boards and whiteboards for administration.
- Equipment trolleys (for mobile storage and preparation) – these should be the same height as benches.
- Shelving should be $\leq 2\text{m}$ high, stable and secured to a wall. Floors should be designed to cope with maximum loads, especially where rolling storage is installed. Stepladders should be provided: height equal to the top shelf, with grab rails and platform.

Equipment

Equipment used in Prep Rooms can be extensive, and it should be considered carefully at the design stage, especially because of the space needed, the dimensions of furniture surrounding it, and the range of services required to make it work. The main types of equipment include:



- **Fume cupboard:** this should be installed within the chemicals preparation zone. The fume cupboard should be ducted, with gas, cold water, drainage and electrical services all required (see page 14).
- **Washing up machine:** Positioned in the wet area with electricity feed plus hot and cold water (anti-siphon) and drainage.
- **Still, for producing distilled water:** Wall mounted, with 13 amp electrical sockets (often two), cold water feed and drainage.
- **Drying cabinet:** Located near the wet area, with electricity supply and bench space.
- **Fridges:** One fridge should be supplied for experimental material with an additional fridge provided for staff use (food storage, etc). A 13 amp socket will be required for each fridge, and the fridges should be positioned under a bench of suitable height to accommodate them.
- **Freezer(s):** Again, one or more, with corresponding electrical sockets, fitted under a bench.
- **Ice maker:** These can be benchtop models or floor-standing. Electrical feeds from 13 amp sockets will be needed for both options.
- **Emergency eyewash:** This should be located by the chemical and wet preparation areas, and should provide a constant flow of clean, cold water.
- **Computer and printer:** For administrative use. This equipment would require mains electricity, plus local area networking links to the Internet and the school's intranet.



■ Photograph courtesy of Keystage, www.keystage.com

Services

Safety and security concerns are just as important in the Prep Room as they are in the science lab. Prep Rooms require:

- Master controls (emergency shut-offs) for gas, electricity and water; plus zoned controls for isolation and maintenance.
- Colour-coded pipes, with direction of flow clearly marked.
- ICT: Internet/intranet access, with a telephone connected to the school telecommunications system.

Fire, Health & Safety

As with the science lab, Prep Rooms require:

- Noise, fire, smoke and fumes to be contained.
- Fire extinguishers (CO₂ – not water based and preferably not powder) and fire blankets.
- First aid kits.
- Emergency Eyewash.
- Emergency alarms points in the Prep Room, or close to it.
- Telephones, to reduce the safety risks of working alone.



■ Photograph courtesy of Keystage, www.keystage.com

Environment

Prep Rooms have a particular need for natural light (as Science Technicians work within the Prep Room environment for most of their day) and good ventilation (≥ 6 air changes per hour).

Other science areas for consideration

Learning areas

For example: demonstration theatres, individual learning pods, group discussion areas, student resources bases, study areas. All of these need good mains electrical provision and ICT access.

Where gas, water, electricity services are provided, all master controls, fire and Health and Safety provision are required. Security and supervision also need to be addressed.

Greenhouses, environmental areas, ponds, etc.

These should be sited near, or within, science areas for better security and supervision, and be able to receive plenty of sunlight as well as protection from the wind.

- Greenhouses will also need water and drainage, plus mains electrical power and lighting. Electrical services should be water-proofed.
- Ventilation and heat control should be operated by roller blinds and automatic windows.
- Heating should be via a thermostatically controlled fan, independent of school heating system.
- Watering system – automatic.
- Lighting – standard 300lux for working; 11000-21500 lux for plant growth (see *Guide L14*, CLEAPSS).

Support areas

- Management and administration areas should be sited adjacent to the Prep Room and science lab.
- Work stations for teachers, technicians and support staff should be supplied, each with secure personal locker, table, office chair, filing cabinet, ≥ 4 electrical sockets and ICT access (Internet and school intranet).
- Meeting rooms should be provided for interviews, counselling, etc., separate to other rooms. Electrical sockets should be available in each room, along with telephone and ICT access, chairs and tables.
- Secure stores for paper, textbooks, exam papers, etc., with stable shelving $\leq 2\text{m}$ height.
- Social/refreshment areas may be integrated with Management areas
- Food and drink preparation: This requires clean surfaces, sink and drainer with hot and cold taps, separate or combined fridge and freezer, water cooler, kettle, microwave, toaster and other food preparation devices as required. Cold drinking water, hot water facility and drainage is necessary, along with suitable number of 13 amp electrical sockets.
- Furniture: This should consist of easy chairs, coffee tables, etc.



■ Photograph courtesy of Keystage, www.keystage.com

Miscellaneous

- Toilets: Staff, pupils and disabled toilets should be provided, with easy access from science areas. *Note: staff toilets must be separate from pupils' toilets, and male toilets separate from female.*
- Cleaning and maintenance: Stores for cleaning and maintenance materials should be completely separate from labs, Prep Rooms and science stores.



DDA (Disability Discrimination Act)

See *Building Bulletins B102, BB93, and Exploring Access*

- Access: Provide ramps, wide doors, lifts to all floors (to take wheelchair and helper), adjustable benches.
- Décor: Way marking – signs, colour contrasting handles and edges, etc.
- Acoustics: Including supplementary equipment for hearing impaired.
- Lighting: Special attention to good lighting standards and control of glare is required.
- Environment: Careful consideration of heating, ventilation and humidity – all of which may need extra attention for individual needs.

Project Faraday was a major research and design project initiated by the former government's Department for Children, Schools and Families (DCSF) to radically rethink how science is taught in schools and develop designs for new science facilities in UK schools.

The project commenced in December 2006. The main research and design phase concluded in December 2007, but follow-up activity remains on-going, and many of the partner schools involved in the project have begun construction of their new facilities.

The DCSF commissioned three teams of designers, educationalists and practitioners to develop the exemplar designs. Each team was partnered with two schools that were being re-built as part of the 'One School Pathfinder' programme (part of Building Schools for the Future) and provided advice to six refurbishment projects. These 12 schools provided at least one demonstration project in each Government Office for the English Regions.

Building Schools for the Future (BSF) – including Project Faraday

Partnerships for Schools (PFS) gives guidance to Building Schools for the Future (BSF) teams in local authorities, including a 'Schedule of Accommodation' (SoA) and a 'Facilities and Services Output Specification' (FSOS). This guidance lays out ideas that encourage design away from the 'one-teacher-one-laboratory' approach and also incorporate the ideas developed in Project Faraday. The process of matching architectural design to the future teaching and learning approaches that a school is planning is considered vital.

Within the PFS's guidance, science accommodation is one of the 'Suites' that make up the whole school. Grouping curriculum areas in suites is intended to help:

- widen the range of settings for teaching and learning; that is, the types of spaces and the sizes of spaces
- blur the distinctions between informal and formal spaces
- enable collaborative teaching; indeed collaboration (even team teaching) is almost a necessity under these design ideas
- enable pastoral organisation and social provision to be distributed around the school if this is part of the school's plans

The overall floor area for the Science Suite would be the floor area provided under traditional calculations for an all-laboratory department, plus some provision from whole-school spaces (such as for administration, social, pastoral, and toilets).

In whole-school terms, science teaching accommodation is considered as 'Light Practical'. Each school will have differing requirements but spaces could include:

- classrooms
- science studios
- specialist/fully serviced laboratories
- large group/demo areas
- interactive/immersive spaces
- outdoor spaces
- informal small group/discussion spaces

Laboratories and other spaces can be linked in various ways to form larger working areas; e.g. 'Superlabs'. This pairing is often achieved by movable walls.

The balance of numbers of laboratories to other learning spaces must prioritise the practical science curriculum that the school is planning.

A Science Suite would also include:

- a Central Hub*, and
- practical support and preparation spaces with:
 - learning resource area(s)
 - staff work rooms and offices (for curriculum and pastoral leaders)
 - (separated) spaces for discussions (staff-staff, staff-pupils, pupils-pupils)

where these are part of a planned distribution around the school.

*** Central Hub**

This is intended as the focal point for the suite. It should not be used to provide basic, timetabled teaching areas, as staff and pupils require access to it at all times.

It might include the following areas:

- social
- direct access to toilets
- parking areas for wheelchairs and other special needs equipment
- learning resource / ICT provision
- circulation to surrounding spaces

Staff offices, workrooms and prep areas should open off the Central Hub; allowing passive supervision of pupil areas. Discussion spaces may be part of the Central Hub or have direct access from it, but should be separated visually and acoustically.

Teaching accommodation

Classroom

Floor area $\geq 56\text{m}^2$. No provision for practical work, but electrical sockets for pupils and teacher, plus data projection as standard.

Science Studio (also referred to as Dry Lab)

Floor area $\geq 70\text{m}^2$. 'Lightly serviced' – i.e., as per Laboratory (see *main guide, above*), but with no gas services for pupils and maybe more limited water services. Teacher's demonstration bench, with all services (including gas). All master controls and health and safety features.

Fully serviced / specialist laboratory (also referred to as Practical Zone)

Floor area $\geq 90\text{m}^2$. As per Laboratory (*see main guide, above*), including fume cupboard; ≥ 2 fume cupboards for specialist lab intended for A-level Chemistry teaching.

Large group / demo area (also referred to as Demonstration Theatre, etc)

Floor area $\geq 105\text{m}^2$, maybe as much as 140m^2 . Intended for large groups of pupils watching teacher presentations and/or pupils engaged in dramatic presentations. Demonstration area with all services, master controls and safety features.

Interactive / immersive spaces (also referred to as Incident Centre, Faraday Room, etc)

Floor area varies, but usually accommodates class of ≤ 30 . Often ICT rich, with few, if any windows (and therefore forced ventilation).

Informal small group / discussion spaces (also referred to as breakout spaces, creativity pods, zen zones, indoor learning bases)

Example: maximum of 4 pupils would give a floor area of 9m^2 . Visually separated from other teaching areas, but readily accessible from them; may also be acoustically isolated.

These are not timetabled spaces, nor for use as staff offices.

Outdoor spaces

Environmental areas, external labs, covered outdoor learning spaces, science gardens, etc.

These are intended to extend science accommodation and further blur boundaries of learning spaces. These are not timetabled spaces.

Linked spaces (some also referred to as Superlab)

Various spaces can be paired to provide larger working areas; e.g., studio/studio, lab/lab, lab/studio. A Superlab is a pairing of a studio or classroom with a fully serviced lab, to provide a research type environment.

Pairs of spaces are generally linked by sliding / folding doors so that they can be used as one large space or two smaller spaces. Sliding / folding doors to be of high quality, with top and bottom pressure bars, to ensure good acoustic and fire/fume separation.

Main References:

Science Accommodation in Secondary Schools, Building Bulletin 80, 2004, DCSF

Designing and Planning Laboratories, Guide G14, 2009, CLEAPSS

Project Faraday, 2008, DCSF

Portfolio – a wide range of different lab designs, contributed by many different institutions and commercial firms. Powerpoint, 2010, Andy Piggott

The above documents, along with other relevant guidance, are available with free access, on: www.ase.org.uk/resources/lab-design

Guidelines for excellence in school science accommodation, 2008, RSC – a one page charter of recommendations by the Royal Society of Chemistry available on:

www.rsc.org/AboutUs/News/PressReleases/2008/LabGuidelines.asp

Other references:

Fume Cupboards in Schools, Building Bulletin 88, 1998, DCFS

Acoustic Design of Schools, Building Bulletin 93, 2003, DCFS

Design for Fire Safety in Schools, Building Bulletin 100, 2007, DCFS

Ventilation of School Buildings, Building Bulletin 101, 2006, DCSF

Designing for Children with Special Educational Needs in Mainstream and Special

Schools, Building Bulletin 102, 2008, DCSF

Exploring Access, Lucy Naish et al, 2003, RNIB

L93: Managing Ionising Radiations and Radioactive Substances, 2008, Guide, CLEAPSS

UP11: Gas installations for educational establishments, International Institution of Gas Engineers and Managers, IGE/UP/11, Edition 2, 2010

Education (School Premises) Regulations, 1999

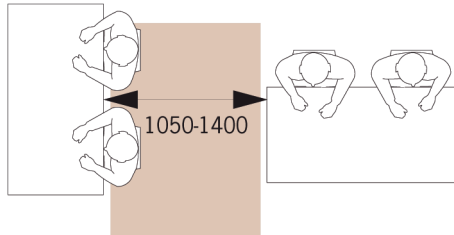
The Water Supply (Water Fittings) Regulations, 1999

Organisations

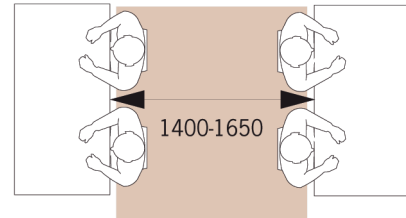
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|-----------------|--|
| ASE | Association for Science Education College Lane, Hatfield, Herts AL10 9AA Tel: 01707 283000 www.ase.org.uk |
| APEC | Andy Piggott APEC Educational Consultancy 71 Field Way, Chalfont St Peter, Gerrards Cross, Buckinghamshire SL9 9SQ Tel: 01753 885222 www.andy-piggott.co.uk |
| CLEAPSS | CLEAPSS The Gardiner Building, Brunel Science Park, Kingston Lane, Uxbridge UB8 3PQ Tel: 01895 251496 www.cleapss.org.uk |
| DfE | Department for Education Sanctuary Buildings, Great Smith Street, Westminster, London SW1P 3BT Tel: 0870 000 2288 www.education.gov.uk |
| NCSL | National Science Learning Centre University of York, York YO10 5DD Tel: 01904 328300 www.sciencelearningcentres.org.uk |
| PfS | Partnerships for Schools 33 Greycoat Street, London SW1P 2QF Tel: 020 3301 7000 www.partnershipsforschools.org.uk |
| Project Faraday | GovEd Communications PO Box 1283, Bedford MK44 1WW Tel: 01234 782647 www.goved.co.uk/projects/faraday |
| SSERC | SSERC 2 Pitreavie Court, South Pitreavie Business Park, Dunfermline, Fife KY11 8UB Tel. 01383 626070 www.sserc.org.uk |

1. Safe Distances

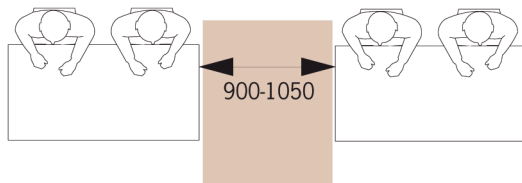
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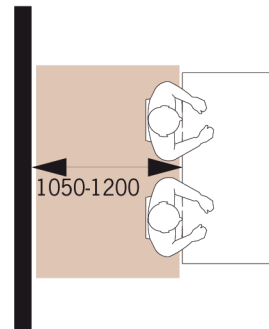
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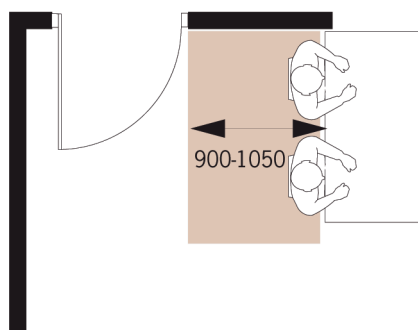
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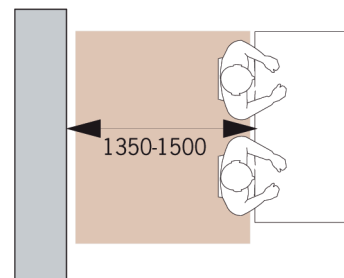
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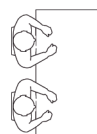
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Key



Circulation

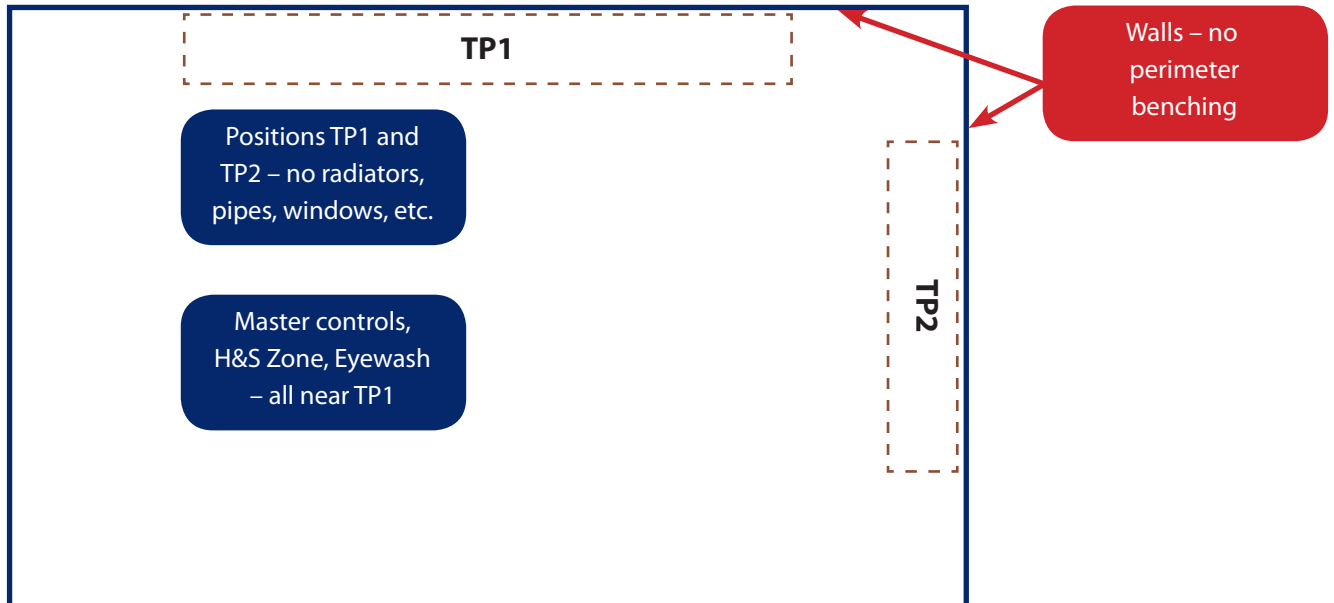


Pupils and table

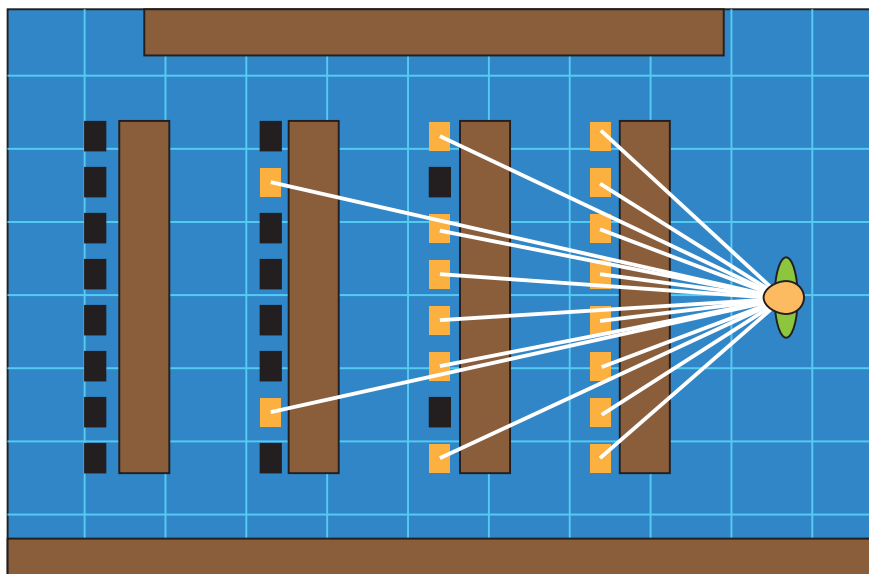
Coats and bags
storage

Plan from Building Bulletin 80, 2004, DCSF.
Courtesy DCSF

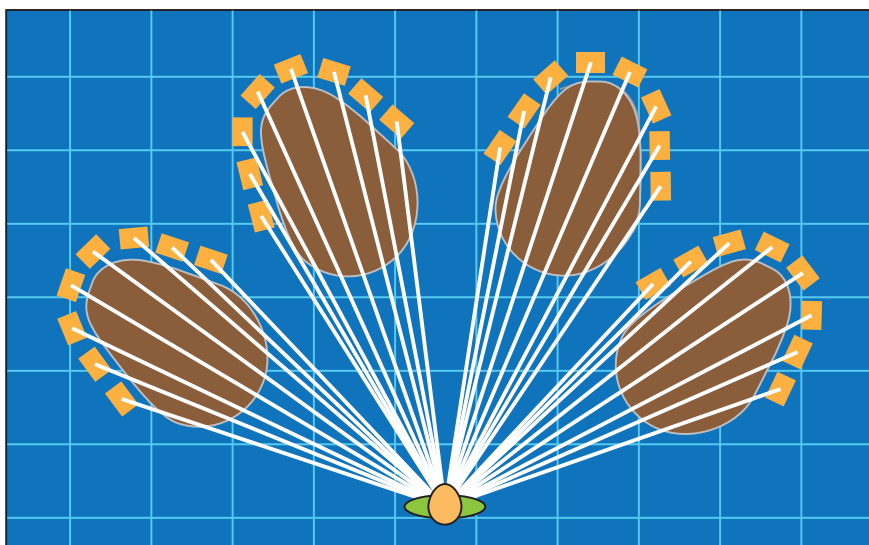
2. Teacher Positions 1 and 2



3. Sight lines



Half of all pupils
cannot see
the teacher.



All pupils
can see
the teacher.

4. Stools damaging floor



Stools with thin tubular steel legs fitted with ordinary plastic ferrules will quickly lose their ferrules, then drill holes in the floor. Steel ferrules should be ordered with such stools.

5. Health and Safety Zone



Science labs should have a wall zone specifically for health and safety equipment .

6. Emergency eye wash



Bench mounted.



Wall mounted.

Eyewash photos courtesy Arboles

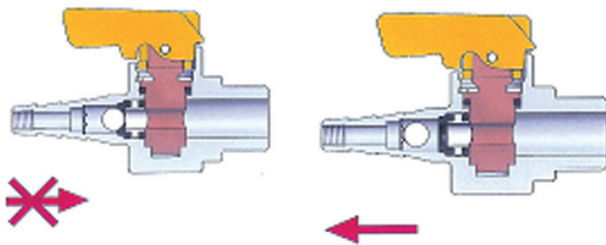
7. Control of services – gas/electricity/water



Gasguard II photograph courtesy Flamefast (UK) Ltd

Science labs and Prep Rooms should have a master controls for gas, electricity and water isolation.

8. Gas taps



Gas taps should have definite on/off positions, anti-rotate fixing to bench, non-return valves and restrictors.

9. Robust water tap



Gas and water tap photographs courtesy Arboles UK Ltd

Water taps should be robust, with anti-rotate fixing to bench and front-operated controls.

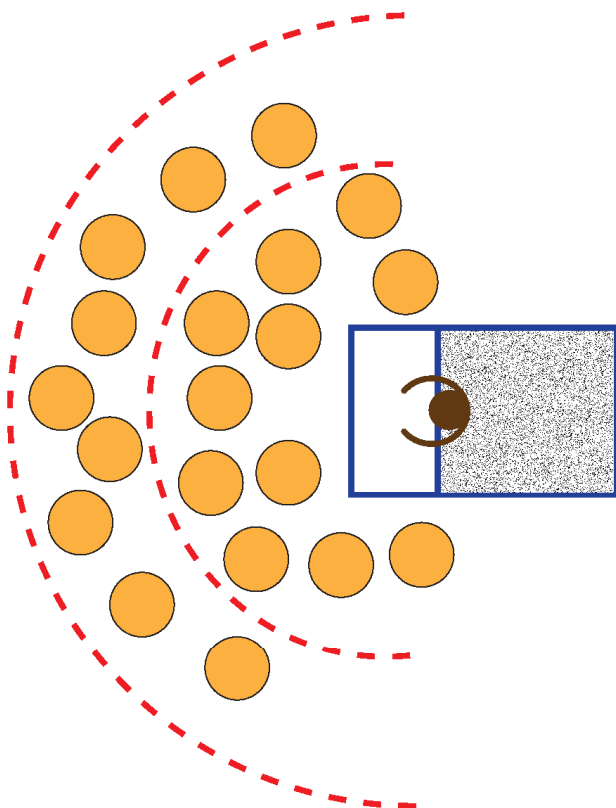
10. Teacher base, with services



■ Photograph courtesy of Keystage, www.keystage.com

The teacher base should have secure storage for lap top and personal items while conducting lessons, and be equipped with all main services – i.e. electrical sockets, gas, water, etc.

11. Fume cupboard optimum working zone



Fume cupboard optimum working zone for demonstrations of radius 2m in front and to the sides of the fume cupboard. Example based on 20 pupils seated and standing. Radius lines represent 1.5m recommended working zone. All fixed benches and furniture are ideally located outside of this working zone.

■ Illustration based on Building Bulletin 88, *Fume Cupboards In Schools*, Section 5: The siting of fume cupboards.



Gratnells have been supplying science storage system to schools worldwide for over thirty years. Unlike rigid industrial shelving and incompatible flimsy plastic trays, our approach is flexible and integrated. Our frames hold different depths of strong, sturdy trays, and our tray inserts ensure safe handling of laboratory materials and equipment. We also have a range of trolleys which enables safe transportation from the Prep Room to the Science Lab. What's more, we've designed complete storage areas for numerous schools throughout the UK.

If you would like to know more about how Gratnells can help you design the perfect School Science Lab and/or Prep Room, using our FREE GratCAD software, which contains 2D and 3D modelling for AutoCAD*, Autodesk 3ds Max* and most other ACIS*-based modelling programs, then call us on **01279 401550**. We also offer consultancy and assistance in implementing School Science Lab and Prep Room storage areas.

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