Business Engagement Assessment	
Title of Proposal	***Revision of Departmental Guidelines on ventilation, indoor air quality and thermal comfort in schools***
Lead Regulator	*Education Funding Agency, Department for Education*
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Date of assessment	*February 2016*	Stage of assessment	*Discussion*
Net Cost to Business (EANCB):	*Cost neutral if equipment with a reasonable maintenance cost is procured*	Commencement date	*October 2016*
Which area of the UK will be affected by the change(s)?	*England*	Price and Present value base years	*1st Quarter 2016 (Price/Present Value)*
Does this include implementation of Red Tape Challenge commitments?	*No*	Is this directly applicable EU or other international legislation?	*Alignment with European Energy Performance of Buildings Directive and Euronorms on thermal comfort and Indoor air quality*

Brief outline of proposed change in regulatory action

Changes to DFE guidelines on ventilation and thermal comfort in schools. See table of changes at Annex 1.

Why is the change proposed? Evidence of the current problem?

To improve thermal comfort and indoor air quality. To prevent summertime overheating and thermal comfort problems in schools.

Which types of business will be affected? How many are affected?

Private building control bodies, independent schools, building services engineers, architects, building contractors and manufacturers.

How will the change impact these businesses?

Summary of costs and benefits

Direct Benefits
The Priority Schools Building Programme (PSBP) has piloted the new guidelines in BB101 and shows direct benefits to schools in lower capital costs, improved comfort conditions and reduced energy costs.

The PSBP programme has seen the development of new lower capital cost ventilation systems which benefits schools. New products have been introduced due to innovation in the school ventilation market which has reduced the cost of systems used to ventilate classrooms.

There is an increase in costs due to the EFA Technical guidance for PSBP to use ducted fume cupboards in preference to mobile fume cupboards. However, this cost increase is outweighed by the other cost savings. This is not strictly a regulatory requirement as it is an EFA requirement for government funded projects contained in the EFA technical guidance on ventilation of specialist spaces and not included in BB101. We have included the cost in the analysis as we consider it is good practice that we would expect many projects in the private sector to apply.

Quantifiable direct costs and benefits included in Estimated Annual Cost to Business
A summary of the quantifiable costs and benefits considered in the calculation of the EANCB is given in Table 1 below. A detailed spreadsheet calculation of the NPV is also available. This shows that the introduction of BB101 is broadly cost neutral.

An estimated decrease in school building costs of £8.76/(m^2 of gross floor area) is attributable to the lower cost of simpler methods of room based classroom ventilation. (Source: PSBP estimate of reduced cost of revised standards over previously applied BB101 standards.)

The cost of maintenance of room based systems is between £150 and £300 per annum depending on the complexity of the systems.

The ease of maintenance of these systems is a primary consideration in the choice of the system to use. Low maintenance systems are a priority in schools and have consistently been used across the Priority Schools Building Programme. Choice of systems with a lower maintenance cost systems leads to a significant cost saving to schools.

Savings accrue in energy running costs for new and refurbishment projects due to the use of demand controlled ventilation. An estimated 20% reduction in gas consumption for school heating will result in all new schools and a 50% reduction in gas consumption in refurbished schools. (Source: PSBP energy predictions for schools designed to the new standards. See BEA Calculation spreadsheet). Although the carbon reduction is substantial the cost of energy is so low that the saving is offset by increased maintenance costs of the ventilation systems required to meet the comfort criteria.

The revised guidance on fume cupboards makes it clear that ducted fume cupboards are preferable to recirculatory fume cupboards, especially in environments such as schools where maintenance is problematical. The health and safety benefits are not quantifiable and so have not been assessed.

Reduction in the cost of ventilation of school science labs due to the adoption of simpler ventilation systems with intermittent purge ventilation during experiments is available for laboratories with semi-mobile ducted fume cupboards but not for laboratories with mobile recirculatory fume cupboards. This saving is small compared to the increase in the cost of school science fume cupboard exhausts for ducted fume cupboards. Reduction in running costs for ducted fume cupboards offsets some of the extra capital cost of using ducted fume cupboards in place of mobile fume cupboards. There is an overall cost to the introduction of this health and safety guidance but this is small compared to the other direct quantifiable benefits from the revisions in BB101.

Calculation of Estimated Annual Net Cost to Business
The EANCB calculation shows that the NPV over 10 years is sensitive to the maintenance cost of classroom based ventilation systems. The NPV can vary from positive to negative depending on this. The cost neutral point is an annual maintenance cost per classroom of ~£255/annum. At £300/annum the EANCB is £101k with an NPV over 10 years of -£867k. Whereas if the maintenance cost is £100/annum the EANCB is -£341k with an NPV of £2.936m over 10 years.

The calculator attached to the consultation has been set at the breakeven point of £255/annum maintenance cost. On this basis we are confident that the introduction of BB101 can be classed as broadly cost neutral.

The increase in capital costs of fume cupboards is outweighed by the larger cost savings due to use of simpler classroom ventilation systems.

The costs used in the detailed analysis given in the spreadsheet are worst case costs, for example we assume that science labs are located on the ground floor of 3 storey buildings, In practice contractors tend to locate them on the top floor to reduce the length of the fire proof ducts that have to be taken to above roof level. This reduces the cost of installing ducted fume cupboards substantially.

The maintenance cost of £255 per classroom per year for maintenance costs of room based systems is a conservative estimate. The simplest systems used in PSBP have a much lower maintenance cost of probably less than £100 per year.

There is a one off familiarisation cost for private sector building control bodies which is estimated at £84k. See Annex 2.

Indirect Benefits
Reduction in the capital cost of projects accrues from using more energy efficient ventilation systems with lower carbon ratings which avoids the need to install more costly carbon abatement measures such as photovoltaic cells on new buildings to meet carbon targets imposed by Part L of the Building Regulations and as local Planning requirements. This is a significant benefit but has not been included in the EANCB as it is an indirect result of the guidelines and is due to other building regulation and planning requirements to reduce the carbon footprint of buildings.

The new standards applied in PSBP have resulted in the development of new products, design innovation, software development and increased product sales. There has been a benefit to businesses that manufacture ventilation systems, window and ventilation system components and controls and software suppliers. Development of new products is classed as an indirect benefit and has not been included in the EANCB.

Alignment with BS EN 15251 and EN 13779 European standards improves consistency with EU regulations made under the Energy Performance of Buildings Directive. Business confidence will be improved and the market for UK products will be widened as EU wide standards for IAQ and thermal comfort are applied in England.

Improved indoor air quality has been shown to benefit pupil performance. The benefits from improved educational performance cannot be easily quantified and as these benefits are indirect they are not included in the EANCB.

Health benefits accrue to children educated in schools due to reduction in concentration of pollutants in schools and outside schools. There is an extra cost of more sophisticated ventilation systems to reduce levels of pollutants in schools in highly polluted inner city areas. Costs and benefits are not included in this analysis as air quality standards result from separate government and EU air quality guidelines and planning requirements whose regulatory frameworks are outside of Building Regulations and BB101. Guidance is given in BB101 on the health effects of pollutants and on ways to reduce pollutants in schools.

Summary Table 1 for Business Engagement Assessment			
Reduced cost of ventilation systems in new and refurbished independent schools	-£434k/annum =(A-B*G)* (C*E +D*F)	Reduced cost of ventilation systems = £8.76/m^2 [A*G-B] New build area 37572 m^2/yr [C] Refurbished build area 67680m^2/year [D]	Percentage take up of build areas 60% of new build area [E] 40% of refurbishment area [F] Teaching area factor of 40% of gross floor area is teaching area (G) needed to compare A (cost per teaching area) with B (cost per gross floor area) £118.10/(m^2 of teaching area) [A] elemental cost of newer room based hybrid ventilation systems used in teaching areas £56/(m^2 of gross floor area) [B] elemental cost of previous ventilation systems [Ref Building Magazine 22.07.2011 Low cost academy new build and refurbishment model
Annual increase in running costs at current energy prices from use of decentralised systems	£9,439 to £81,476/annum = (H/55-I+J) * (C*E +D*F)*G	Added maintenance costs = £0.73 to £2.18/m^2 (H/55)*G Reduction in energy costs = £0.54/m^2 (I-J)*G	Maintenance cost per room of £100 to £300 (H) depending on choice of system Energy cost of centralised system £4.84/m2 (I) Energy cost of room based system £3.49/m2 (J) C,E,D,F,G as above
Use of semi-mobile ducted fume cupboards in science in place of mobile fume cupboards in independent schools	+£87k per annum= [A] *[B][C-D]	Increased capital cost of semi-ducted fume cupboards	No of Fume Cupboards replaced per year is 30 [A] x take up of measure 60% [B] Capital cost of semi-mobile ducted FC = £2250 +ductwork £6261 +cost of services £3742 = £12253 [C] Capital cost of mobile fume cupboard £3061 + extra cost of ventilation system £2000 +cost of services £2374 = £7435 [D] Annual Running cost savings for semi ducted fume cupboards £150 Filter cost reduction is £500 every 3 years
Familiarisation costs in year 1	£84k	See Annex 2	Total familiarisation costs for private sector Building Control Bodies.

Impact on small businesses

A number of small manufacturers of bespoke control systems, IAQ sensors and ventilation systems and components for schools have seen benefits from the development of new products to meet the EFA facilities output specification which has applied the revised standards on the current central government procured priority schools building programme (PSBP). With the publication of the guidance for all English schools the markets for these products will be widened.

The two main software houses for building environmental performance modelling, TASS and IES, have introduced calculation procedures for the PSBP programme which are now available across other building types. The new adaptive thermal comfort calculation has also been recognised by the LEED and BREEAM environmental assessment methods and included in their methods.

The schools programme has tested the new adaptive thermal comfort calculations of TM52 based on EN 15251 and has led to a suggested improvement of the calculation procedure.

Many small businesses with fewer than 25 staff have been in the lead in developing improved IAQ and thermal comfort. EFA has worked closely with industry in development of the revision of BB101 and learned from the experience of these companies.

Annex 1

Differences between Building Bulletin 101 (2006), other regulatory standards and the new 2016 edition of Building Bulletin 101, 'Guidelines on ventilation, thermal comfort and indoor air quality in schools'.

Section of BB101	Topic	BB101 2006 Ventilation standards	Other regulatory standards	Changes in revised BB101 2016 performance standards	Impact Assessment
Section 2.4 and Sections 3.1 to 3.5	Indoor air quality Ventilation rates of teaching spaces	Standards for new buildings in terms of carbon dioxide concentration and for existing buildings in terms of litres per second per person. Minimum ventilation rates in l/s/person make no allowance for demand control of ventilation and lead to high heat losses due to ventilation when spaces are partially occupied.	Workplace Regulations – ACOP suggests 5l/s/p minimum ventilation rate for all workplaces.	Same standard as BB101 but allows for reduction in ventilation rates due to demand control in new build and refurbishment as standard now in concentration of carbon dioxide rather than l/s/person. In line with EN 15251 and Energy Performance of Building Directive standards for carbon dioxide concentrations in classrooms.	The average overall cost of newer hybrid ventilation systems is estimated at between £47.24 per square metre of gross floor area. These newer systems have been introduced in PSBP schools. The cost of these systems is on average £8.76 per square metre of gross floor area cheaper than the systems that were previously used to meet comfort standards estimated to be at least £56/m^2.
Section 2.5	Indoor air quality Ventilation rates for science labs	5 air changes per hour required in all science labs.	Workplace Regulations HSG 258 COSHH Regulations 2002	Minimum exhaust rates of 4 l/s/square metre of floor area in chemistry labs. Slight reduction in ventilation rates by using l/s/m^2 rate equivalent to 5ach for 2.7m high spaces as most spaces now 3 to 3.2m high. Using l/s/m^2 as ASHRAE 62-1 method is more logical than ach.	Cost reduction for school laboratory ventilation systems as higher rates only needed as slightly lower rate specified. Vent at higher rates for purging room can have higher noise level meaning classroom ventilation units can be used in science labs.
Section 2.5	Ventilation for other practical spaces		Workplace Regulations HSG 258	Minimum exhaust rate of 2.5 l/s/m^2 in all other practical spaces as per Art spaces in ASHRAE 62-1.	No cost impact as equivalent to ventilation rate of 5l/s/person for 24 people required by Workplace Regulations.

			COSSH 2002		
Section 2.5	Fume cupboards		HSG 258 CIBSE/ASHRAE minimum separation distances BS EN 14175 fume cupboard exhausts	Fume cupboards, LEV and kitchen exhausts brought into line with minimum standards by reference to ASHRAE 62-1 separation distances	Cost increase of fume cupboard flues to bring them up to a safe height of 3m above roofs in accordance with HSG 258 and EN 14175. Cost increase for ventilation systems in labs with mobile fume cupboards as intermittent purge not possible. Take up of measure in 80% of fume cupboard new purchases and replacements Mobile fume cupboard capital cost higher than semi ducted FC. Filter replacement cost for mobiles. Annual testing more expensive for mobile FCs.
Sections 3.1 to 3.5	Air quality Guidelines on reduction of external air pollution	Reference to: AD F National Air Quality Strategy DETR, 2000 CIBSE TM 21 Minimising Pollution at Air Intakes, 1999 Guideline figures for all major pollutants were considered, eg,	Building Regulations Approved Document F (refers to WHO 2005 External Air Quality Standards) National Air Quality Objectives WHO Indoor Air Quality Guidelines HSE Workplace Regulations	Update of guidelines by reference to World Health Organisation (WHO) Indoor Air Quality Guidelines (2010). Levels for external pollution from $PM_{2.5}$ included for first time based on 2008/50/EC Guideline values. $PM_{2.5}$ external levels are closely correlated with NO_2 levels so no cost increase.	No cost increase as where $PM_{2.5}$ external levels are high NO_2 levels are also high and guidance already exists in AD F, eg, AD F contains guideline values for NO_2. Impact assessment of the health benefits considered during revision of AD F and European Council Directive. Health benefits due to better application of 2008/50/EC levels to schools due to improved guidance leading to better IAQ in schools in polluted areas,

		NO_2, Formaldehyde, PM_{10} except for $PM_{2.5}$.			
Sections 3.6 to 3.10	Thermal comfort criteria for heating and ventilation system design		Adaptation of ISO 7730 Thermal comfort standards to make them applicable to schools Standards are described in Section 3 and summarised in Table 3.9 covering drafts, vertical air temperature difference, warm and cool floors, and radiant asymmetry. and Table 3.10 covering local air velocity, vertical air temperature difference, warm and cool floors, and radiant asymmetry.	BB101 guidance brought into line with CIBSE good practice and ISO 7730 thermal comfort standards.	ISO 7730 and EN 15251 are implicit in EPBD, Building Regulations Part L National Calculation Method and Workplace Regulations - Temperature requirements. No cost increase over regulatory standards: implicit in EPBD, Part L NCM energy calculations and in temperature requirements of the Workplace Regulations. Detailed standards contained in ISO 7730 and in EN 15251. Benefit due to improved guidance leading to reduced thermal stress and improved thermal comfort in summer and winter.
Section 3.7.1 and Table 3.9	Criteria for cold drafts Section 3.7.1 and Table 3.9 give the criteria to avoid cold draughts.	No criteria given for prevention of cold drafts	Thermal comfort standards contained in ISO 7730 and EN 15251 are implicit in EPBD and the Building Regulations Part L National Calculation Method. Workplace Regulation 7 - Temperature requirements.	BB101 guidance brought into line with CIBSE good practice and ISO 7730. Lack of criteria on cold drafts led to inadequate single sided window design that was not used in cold weather due to comfort problems and to excessive drafts from mechanical ventilation systems.	No cost increase over standards in ISO 7730 and in EN 15251 and in temperature requirements of the Workplace Regulations. Benefit due to improved guidance leading to reduced thermal stress and improved thermal comfort in summer and winter.

Sections 3.11 and 3.12	Criteria to prevent summertime overheating .	Hours of exceedance over a summertime fixed temperature threshold. “There should be no more than 120 hours when the air temperature in the classroom rises above 28°C”.	EN 15251 adaptive thermal comfort standard.	Move to adaptive thermal comfort calculation in line with standard in CIBSE TM 52 and EN 15251 calculation procedure. “During the period 1st May to 30th September for the defined hours, the number of hours when the actual operative temperature exceeds the maximum temperature allowable by EN 15251 for the Category of building by more than 1^{o}C should not be more than 40 hours”. Category III building adopted as minimum standard for new schools.	Change in design by omission of suspended ceilings and use of thermal mass together with boost ventilation in summertime represents a very small increase in cost over designs to meet former BB101 thermal comfort standards that were inadequate and led to widespread overheating, cold drafts and other thermal comfort problems in schools. Benefit due to improved guidance leading to reduced thermal stress and improved thermal comfort in summer and winter.
Section 4	Window design changes			Climate based daylight criteria for summertime reduces heat gain and reduced window areas result compared with previous Daylight Factor design criteria.	Cost reduction from reduced window areas in classrooms resulting from Climate Based Daylight design leading to less solar gain reducing cost of measures to avoid summertime overheating. The cost savings due to this measure are not included in the analysis of EANCB as BB101 does not include criteria on daylight design.

Annex 2: Familiarisation cost

One-off costs (current prices)		Building Control Bodies (BCBs)	Method and data source
A	Number of staff in Building Control Bodies needing to familiarise themselves with revised standards	60 x 5 = 300	Internal data plus assumption Registers of Approved Inspectors (CIC and ACAI)
B	Staff time	4 hours	0.5 days training each
C	Average Hourly Employee Cost	£40/hour	£40/hour taken from 2012 OGC Framework rates for Technical support consultancy
D	Travel and conference cost	£100	Cost of attendance at regional conference of Association of Building Engineers
E	Proportion of conference cost for ventilation standards for schools	½	Past history of ABE and CIBSE conferences
	Total one-off resource costs paid by the independent school sector	**£84k A*(B*C+D)*E**	

The total familiarisation cost is equal to £84k.

Commentary on familiarisation and admin costs

1. **Familiarisation costs**

These costs correspond to the hours invested by Building Control Body (BCB) professionals to become familiarised with the changes that are being introduced. The familiarisation costs for BCBs are estimated at £84k.

Building Control Bodies
We have estimated the cost to private sector BCBs only.

There are currently 90 Approved Inspectors registered on the Construction Industry Council (CIC) website. These range from specialist individuals to very large businesses. Of these, around 60 are listed on the Association of Corporate Approved Inspectors (ACAI) website. School contractors are likely to use the 60 listed with ACAI rather than the 90 registered with CIC. We have assumed that these 60 practices will each need to train 5 of their staff for schools work. This estimate is likely to be an upper bound as not all the large corporates will do schools work, and some of the 90 registered practices consist of just 1 individual.

The familiarisation training would typically occur at a conference of the Association of Building Engineers (ABE) that would cover all changes to Building Regulations in one morning session. The usual ABE conference fee is £60 per delegate. The changes in ventilation standards could be covered in half of a 4 hour session. Cost of travel and attendance would be an average of £100. The hourly rate for this type of building professional, according to the OGC framework, is around £40/hour including wage costs and overheads. A reasonable estimate of the one-off cost per person for familiarisation is (£160 + £100)/2 = £130 giving a total cost for 5 staff per BCB of £650.

The total cost for BCBs is equivalent to one-off costs of £84k as shown in the Table above.

Publication one-off costs (costs of producing supporting guidance)
The revised ventilation standards have been written by the Education Funding Agency (EFA) for use in the PSBP.

The cost of the time of the industry ventilation experts who have worked on the revision as part of the advisory group and working groups has been estimated at £50k. However, consistent with *HMT Green Book* guidance, these costs have been excluded from the appraisal as they have already been incurred (they are a sunk cost). In fact, there was no charge made for their advice.

Cost of publications
There will be no cost to building services engineers, architects and designers in accessing the revised guidance as EFA will publish the standards and guidance free in electronic format.