

THE INTEGRATION OF SPRINKLER SYSTEMS INTO SCHOOL FIRE SAFETY PACKAGES WITHIN SOUTH AND WEST WALES

Irfon Jones¹ and Max Graham²

¹ *Carmarthenshire County Council, Building Control Unit, Building 16, St David's Park, Jobswell Rd, Carmarthen, Carmarthenshire, SA31 3HB, UK*

² *Faculty of Advanced Technology, University of Glamorgan, Treforest, Pontypridd, CF37 1DN, UK*

This research investigates the issue of sprinkler systems in schools and whether or not their inclusion should be considered integral within a schools fire safety package. Disturbingly, ever increasing instances outline the event and incidences of fire and its effect at these educational premises. A valuable community asset, pupils and staff work can all be erased in a mere few hours. This research highlights the problem of fire losses in schools and the legislative frameworks which govern active fire safety precautions. The application and viability of these legislative frameworks are explored, along with the attitudes and perceptions of major stakeholders and regulatory bodies. A sprinkler system application has been included as a case study to demonstrate their application. Complementary to the above research, primary data was collated in the form of structured interviews involving key regulatory authoritative personnel from both the Fire Authority and Building Control. In addition to the interviews a newly constructed school in South West Wales was case studied in order to outline the means by which the designer can integrate a sprinkler system into a schools fire safety strategy. Finally, conclusions are drawn from an analysis of the qualitative data underpinning the fact that sprinklers have a contribution to make with respect to their integration within a schools fire safety package. However it will remain for the 'Local Education Authorities' to strike a balance between life-safety, cost, and property protection.

Keywords: fire, legislative framework, personnel, fire authority, building control, Local Education Authority.

INTRODUCTION

This paper draws upon the research undertaken for an undergraduate dissertation. The author in his capacity as a 'Local Authority Building Control Surveyor' for Carmarthenshire County Council, encounters on a daily basis, building control applications in relation to the construction of new schools and the extension or renovation of existing schools within the county.

They include nursery, primary and secondary schools with the estimated cost of works to a school varying from £10,000 to £22 million. Current legislation however states that only 'life safety' is a statutory requirement and that providing the physical or passive aspects of the school building are compliant with a safe passage of egress being afforded, then the legislation does not insist or extend to property protection.

¹ Irfon.Jones@carmarthenshire.gov.uk

² msgraham@glam.ac.uk

However in today's ever changing educational and indeed communal environment, innovation in terms of design, and more importantly, the ability of the building to be user friendly and flexible is of paramount importance. This does unfortunately result in some degree of design departure from statutory legislative guidance such as an increase in travel distances, compartment sizes and general passive fire safety measures. For this reason the research aims to establish whether the use of sprinkler systems would provide an 'active' form of compensatory feature in terms of life safety and property protection within schools.

BACKGROUND TO THE PROBLEM

Disturbingly, figures and statistics which are increasing on a year by year basis outline the event and incidences of fire at these educational premises. Although their causes vary, many are unfortunately of a malicious nature and the consequences are more often than not always the same.

The loss of a school and its contents as a valuable community asset, which is often being utilised for a wide range of extra-curricula activities, has severe consequences. According to Local Government Associations and the Automatic Fire Sprinklers publication/tool kit, (2004), only some of the consequential losses are covered by insurance.

In a typical year in the UK, the Fire Sprinkler Association (FSA 2006) reported 2,000 school fires, with 90,000 schoolchildren having their education disrupted, and 80,000 families affected. Moreover the FSA identified that currently only 150 out of the 28,000 schools in the UK have a fire sprinkler system fitted. Furthermore, in a recent article in the Fire Sprinklers Association, South Wales Chief Fire Officer Fraser B, (2006) outlined his concerns that "amazingly, given the overwhelming evidence, even new buildings are not always fitted with sprinkler systems.' He added: "While some council's in South Wales are beginning to champion the cause locally, others are letting the absence of central direction and worries about water damage cloud their judgement".

PUBLISHED DATA

Figures published by Zurich Municipal Insurance (2005) demonstrate that the cost of fire damage to schools within the UK in 2005 was an estimated £67 million, a £16 million reduction from the £83 million reported in 2004. This however, did not mark the start of a downward trend, for in March 2006 alone; school fires cost an estimated £22 million, compared to the monthly average in 2005 of £5.5 million. Related costs incurred as a result of school fires have increased by more than 37% over the last 10 years. The above is further underpinned by Munnoch Guy (2000), Managing Director of Zurich Municipal who states that "these disturbing financial figures mask hundreds of individual tragedies. Each school that is damaged by fire creates its own appalling catalogue of stories of disrupted education, lost teaching notes and traumatised communities".

RESEARCH OBJECTIVES

By its very nature, the causes and effects of fire are factors that are outside the remit of Building Control, but the built environment is not. It is this factor that is the focus of research; to establish whether sprinkler systems should be an integral part of the fire safety package in schools.

The primary objective of this research is to address the question, "Should sprinklers be an integral part of the fire safety package in Schools?" As part of the research, it was also necessary to investigate the role sprinklers have to play as a compensatory feature in allowing designers a degree of flexibility, which under current legislation is limited.

A range of additional factors needed to be incorporated within the research; these included the history and potential of sprinkler / fire suppression systems, a review of current legislation relating to active fire protection measures, and an appraisal and quantification of the benefits of installation in terms of regulatory dispensation. The latter involved the consideration of increased travel distances, larger compartment sizes, flexibility of spatial planning, insurance premiums and their economic implications which included financial rebates and pay back periods. The views and concerns of interviewees were examined to determine whether sprinkler/fire suppression systems have a role to play in enhancing the life of a school.

RESEARCH METHOD

Primary research was collated in the form of four structured interviews with two Senior/Principal Local Authority Building Control Surveyors one from Carmarthenshire the other from Ceredigion. The other two interviewees were senior Fire Authority; Fire Safety personnel sourced from the 'Mid and West Wales' and 'South Wales Fire Authorities'

Governing Legislation

In order to comprehend how and where the use of active suppression systems such as sprinkler systems may be integrated within a school building's fire safety package, the research sought to provide an insight into the current legislation that governs and guides all concerned with this type of building.

Essentially, present day fire safety legislation is based upon the recommendations set out under the Report of the Department Committee on the Fire Service. This report undertaken in 1970 was known as 'The Holroyd Report'. It should be noted however that up until April 2001, Building Bulletin 100 (para 1.1) highlights the fact that all schools maintained by Local Educational Authorities (LEAs) in England and Wales were granted exemption from the Building Regulations with no specific legislation being enforced. Today however, new and extended/refurbished schools are designed and constructed in accordance with the relevant statutory requirements as set out under Schedule 1 of the Building Regulations 2000. These regulations are performance based, rather than prescriptive and are supported by a series of Approved Documents, which offer ways of satisfying the regulations.

In order to satisfy the afore mentioned, the Design Guide to Building Fire Safety (Stollard and Abraham, 1999) outlines the objectives, tactics and components that are integral ingredients to providing any fire safety package, which apply not only to schools but to most buildings.

With regard to current Building Regulations, the most notable document pertaining to fire safety is 'Approved Document B 2000 (ADB) Fire Safety'. However its functional requirements advocate minimum standards only, and view the use of sprinkler systems as a "compensatory" and not obligatory feature in a schools holistic fire safety package.

This presents limitations as outlined by Raynsford (2000) the Minister for Housing and Planning, as “...the, Building Regulations are made primarily to ensure health and safety in and around buildings; they do not cover property protection.”

It should also be noted that they are only applicable to 'building work' and do not account for existing building/school stock. A point of interest here is that this research has noted that most published statistics in respect to sprinklers are based on figures gathered and collated from the existing building stock. This raises the question that if Building Regulations were to introduce sprinklers as a compulsory feature this would still only apply to new and refurbished work. It would not therefore impact on the existing school building stock.

Whilst the above ADB ensures minimum levels of life safety, its supplementary counterpart Building Bulletin 100 (BB100) is specific as its title suggests, 'Designing and Managing against the risk of fire in schools'. Its principles are “...based on identifying and assessing the risks presented in the different areas of a school, and where necessary taking action to reduce them.”

It is also interesting to note that it acknowledges that school building usage today has become more flexible in response to the need of the local community. It also raises the issue of arson within schools and cites that; “...the number of arson attacks has increased steadily over the years. It is now the largest single cause of fire in schools, with 70% classified as deliberate. Furthermore it adds that “between 1997 and 2001 there were on average 2,119 serious fires per year in educational establishments in the UK of which 1564/ year occurred in schools with a total economic cost of £70million.”

With regard to the introduction in October 2006 of 'The Regulatory Reform Order' (RRO) according to Chitty (2005) its legislative and regulatory jurisdiction “does not influence the design of buildings, it does however influence how they are run”.

Its principles lie in undertaking risk assessments whilst identifying the general fire precautions that have to be in place. However, it should be noted that the use of sprinklers is not mandatory and may be considered as a compensatory feature to aid flexibility of the buildings usage, departure from the requirements of Building Regulations or malicious circumstances such as arson.

In light of the above it becomes apparent that formal legislation and supporting technical guidance cover life safety, whereas property protection i.e. the 'school building' itself, is not covered as rigorously. Furthermore the research exposed an 'Achilles heel' in terms of existing school building stock, as a consequence that present legislation only pertains to 'building work' when new work is undertaken to schools. It is merely advisory to install in existing extension work, remodelling and refurbishment schemes.

Application and viability

The publication by Zurich Municipal (2005) takes the view that a fire sprinkler system should be considered for all new schools. Moreover it strongly advises that;

“... all new school projects include fire sprinklers for the protection of the property.”

In light of the above it is reasonable to ask whether there is a point in terms of fire protection measures, beyond which the additional cost is disproportionate to the added safety a sprinkler system provides. Absolute safety from fire where there is neither risk to life nor property is an impossible ideal. It is for this reason therefore that the

provision of active fire suppression systems such as sprinkler systems and their application needs to be carefully measured. However, their application should not be considered as a 'given' in all cases. As with all active systems there are limits to their functionality and effectiveness. This of course is dependent upon the relative merits or otherwise of individual cases. The criteria identified during the course of the research when ascertaining whether to use suppression systems are; accessibility/location of school, possibility of malicious events (arson), adequacy of security systems, response times of the Fire Authority, adequacy of water supply, building fabric vulnerability, and relevant management procedures. However, whilst considering the above Stollard (1994) debates that, in the case of arson, if preventative measures were inherent within the new school design this may negate the requirement to install sprinklers in the first instance. This theory however is challenged by The British Automatic Fire Sprinkler Association Ltd (2006) as it implies that: "...over the last 10 years Local Authorities have spent millions of pounds in improving school security yet the number and cost of fires shows no sign of decline."

Risk

In terms of risk, the research identified that one must acknowledge that in today's society, recognising the effects of malicious action such as arson is an important factor when considering the integration of a sprinkler system within the school's built environment. It must therefore be recognised that where evidence suggests that arson is a regular and real threat, their use should be considered. With regard to cost, the Chief Fire Officers Association (CFOA 2003) identifies the installation cost of sprinkler systems generally being around 2-3% of new build cost. However, BB100 identifies a cost implication of up to 5% of a building contract value. The CFOA (2003) reports that "...today the school building category is suffering increased losses, costing over £100 million during 2003. It is expected that 2004 will see familiar costs".

The research identified a further point of interest in that the insurance company 'Zurich Municipal' state that: "...insurance companies are prepared to reduce insurance premiums by 65% on sprinkled schools; furthermore they will reduce the excess applicable, typically £ 100k, to nil."

It remains therefore, given the above, that school owners and LEAs should give due consideration prior to installing sprinkler systems. It may be decided that based on a risk assessment the expenditure may be considered unnecessary.

Equally however, if as a result of say, location or design constraints for example, whereby a form of compensatory fire safety feature was required, then their installation should be given serious consideration.

In terms of 'trade offs' the research identified, whilst engaging with Building Control, Fire Authority and BASFA that, subject to the individual merits of individual schemes, 'trade offs' such as increased travel distances, increased compartment sizes, reduced automatic fire detection standard, fewer fire doors and a reduced number of portable extinguishing equipment may be afforded.

Insurance

In view of the unprecedented £25 Billion 'Building Schools for the Future' (2005) programme, the research established that from an insurance perspective, companies pay out some £100 million each year due to fire related claims, with on average, five schools per day being affected.(Zurich Municipal 2005). This figure however is not a

true representation as not all schools are insured; therefore one must assume that this cost is far greater. (Milne 2006) also states “the early part of 2006 saw unprecedented insured costs from school fires”. Alarming (Zurich 2005) claim their own figures reveal that as much as 90% of school fire claims are as a result of arson attacks. The research did however experience difficulty in being able to ascertain the cost to uninsured schools. It follows therefore that opportunities exist to ensure that the failings of the past and indeed present are addressed.

Perception

The concept of the use of active fire safety/suppression systems such as sprinklers has often been regarded as an emotive subject. There are many wide ranging and varying opinions with regard to their effectiveness and reliability. The research outlined the general perception and attitudes of various parties and stakeholders of sprinklers as a constituent part of a school’s fire safety package. From the perspective of a ‘Building Control Surveyor’ the research took account of the perception and attitude of the Design Team, Building Control, Fire Authority, Governmental Authority, Welsh Assembly, Local Authority and Local Education Authorities. Furthermore a newly constructed West Wales comprehensive school was case studied to demonstrate the application of sprinklers.

Interestingly the research found that Carrol, (2004) championed the use of sprinkler by stating that “...the case for sprinklers in schools is stronger now than at any time. It is a worrying fact that schools are still experiencing fires at an alarming rate. Year on year, when the statistics are published for major fires, educational establishments are always on top of the list”. Furthermore, Hall (2006) in his capacity as chairman for The Mid and West Wales Fire and Rescue Authority, recently welcomed the inclusion of sprinklers at ‘Ysgol Gyfun Bryn Tawe, Penlan, Swansea. Ironically though, this was in the wake of total devastation, amounting to some £8 million of damage at the nearby Penyrheol Comprehensive School, Swansea.

During a session at the House of Commons Hansard debate, Barlow (2006) lobbied the Government to “...rethink its current thinking of building regulations and to consider the inclusion of sprinklers in all residential buildings in England and Wales, whilst also giving due consideration to schools. However during the same debate Barlow (2006) acknowledged and questioned the findings of a study undertaken by the Building Research Establishment (BRE) commissioned by The Building Division of The Office of The Deputy Prime Minister wherein it concluded that: “...sprinklers were cost – effective only in buildings of 11 storeys or more and probably cost-effective in residential care homes”. Fitzpatrick (2006) also concurs that sprinklers have a role to play, but takes the view that they are not a panacea and their role is an important one within the ‘package’ of active and passive fire safety measures. Furthermore he argues that: “...sprinklers have a major contribution to make in preventing deaths and injuries, but there is clearly more work to do before we can be certain about the best way forward for their use in different places and circumstances. This view is not however shared by Hart (2006) and Mackay (2006) both of whom are stern advocates in recommending the installation of sprinklers in schools. Similarly, this view is also upheld by Ryder (2006). Furthermore in his capacity as General Secretary of the National Union of Teachers, Sinnott (2004) stated that “Fires in schools cause threat of injury but they also bring disruption to children’s education and severe difficulties for young people when coursework is lost. It seems madness

that a system which costs no more than 1.8% of total build costs yet could bring such benefits is not a requirement “.

RESEARCH OUTCOME

In order to extract and assemble the opinions of appropriate personnel with regards to the issue of sprinkler system integration within schools, research data was assembled following four ‘key’ industry personnel by way of two ‘structured interviews’ and two structured telephone interviews. This approach ensured that the information obtained was representative of both Building Control and The Fire Authorities. The questionnaire consisted of ten questions, all of which were tailored specifically to draw an objective response. These are set out below:

Qualitative Analysis of Interviews

Q1 - Would you agree the current Building Regulations 2000 namely 'Approved Document B - Fire Safety' and 'Building Bulletin 100 Designing and Managing Against The Risk Of Fire In Schools' are adequate in respect to affording guidance on school design.

A1 - Generally, legislation appears to be adequate although there are limitations. However one BCO did not feel legislation was adequate and offered the current rise in school fires as justification.

Q2 - Does the legislation provide solutions for a safe school built environment?

A2 - It is apparent from the above responses that legislation does provide for safer schools. However this covers ‘life safety’ only, the same legislation does not extend to property protection.

Q3 - Do you feel there are areas or aspects within the legislation that need improving?

A3 - There appears to be a 50% difference of opinion with the FO’s expressing relative satisfaction, however both BCOs took the view that legislation does need improving.

Q4 - In your view are designers fully conversant with legislation pertaining to schools.

A4 - All parties firmly assent to the fact that designers are not fully conversant with the relevant legislation. Furthermore they very often lose the opportunity to capitalise on design flexibility by lack of engagement with authorities.

Q5 - Do you feel that the inclusion of sprinkler systems should be obligatory within schools?

A5 - From the above it may be seen that only one BCO had reservation in terms of the obligatory installation of sprinklers, however he was of the opinion that the decision should be based upon a location assessment and the increased probability of arson.

Q6 - Are you happy to ‘trade off’ or compromise with respect to fire safety when there are obvious non-compliance issues?

A6 - Whilst the responses were evenly matched it is apparent that there is a careful balance of risk that needs to be clearly identified. Designers and architects do occasional inadvertently ‘design in’ areas of no compliance. The decision of compromise or trade off must, in view of the above, be a matter for the respective regulatory authority.

Qualitative Analysis of Interviews - Continued

Q7 - What is your general opinion on sprinkler systems?

A7- Generally all the above participants were in favour of using sprinkler systems in schools, although one BCO did suggest that currently, they are being used as fire engineered solutions within the retail industry purely to limit damage to property and stock. Interestingly on this point, one could pose the question – “Are the losses to a schools property and stock of less or greater value than say a large retail store?”

Q8 - Do you agree that the provision of a sprinkler system within a school allows for greater flexibility in terms of design?

A8 - The above statement drew a positive response with 100% of participants agreeing that the use of a sprinkler system would allow for greater design flexibility.

Q9 - Given the choice, what active fire precautionary measures would you consider to be the most suitable for a school.

A9- Again another conclusive response providing it seems sprinklers are not used in isolation. Their use should be in tandem with a correctly specified and designed automatic fire detection system.

Q10 - Would you agree that sprinklers are only used as part of a fire engineered package to rescue designs, i.e. where the application of Approved Document B and Building Bulletin 100 is too onerous?

A10- It emerged that all parties concur sprinkler systems are not only used to rescue designs. Moreover Local Authorities are now beginning to acknowledge and appreciate their ability in ensuring the sustainability of a valuable community asset.

CASE STUDY

In order to demonstrate the means by which the designer can integrate a sprinkler system into a new school’s fire safety package, the research also included a case study of a new mixed, bilingual community comprehensive school in West Wales. This school consisted of approximately 1600 pupils, catering for all abilities between the ages of 11 and 18. The aim of this case study was to illustrate how the designer has achieved greater fire safety flexibility, whilst meeting and exceeding the functional requirements of the Building Regulations and allied legislation. Comparisons with ADB and allied legislation were also outlined in order to highlight ‘trade-offs’.

Design Flexibility

With regard to the project, the design team considered sprinkler protection at an early stage as part of their holistic approach to fire safety. Their remit was to enhance and maximise the school’s flexibility. Through continuous dialogue with Building Control and the Fire Authority, the installation of sprinkler protection was favoured by all parties thus allowing the design team to take full advantage of the flexibilities afforded by sprinklers to create attractive and inspiring spaces within this substantial building. The sprinklers were found to compensate for extended travel distances, inner rooms, a reduction in the number of fire doors, reduced corridor widths and increased design and school usage flexibility in both the dining and performance halls. Reduced insurance premiums were a further benefit.

DISCUSSION

Given the above, and also the depth of qualitative information retrieved from all four interviewees, it is evident that schools are suffering ever-increasing losses from fire. Consequently this has repercussions not only for pupils and staff, but also to the community at large who depend on the school for a wide range of other activities.

The cost of fire losses as outlined in the first chapter are vast, totalling up to £100 million per annum throughout the UK. However, although the Government has committed to spend around £25 billion as identified earlier over the next 10-15 years on a schools rebuilding and replacement programme, legislation does not insist on sprinkler inclusion.

It is evident that legislation caters for passive fire safety precautions as set out earlier and its role is fundamental to providing a safe means of escape. However as outlined by one of the Fire Officers above, sprinkler systems when used in conjunction with an automatic fire alarm system may detect, contain and extinguish fires. Furthermore, an increased awareness with regard to environmental impact and sustainability issues should further support the requirement for sprinklers.

With regard to the Local Education Authorities, the research underpins the fact that schools fitted with sprinklers are generously discounted in terms of annual insurance premiums.

In terms of design allowances and subsequent school facility flexibility, sprinklers undoubtedly have a major role to play and their use is widely advocated by all Fire Authorities; with Building Control however, they are not a panacea.

CONCLUSION

This paper set out to explore the merits or otherwise of installing sprinkler system as part of a school's fire safety package, and consequently pursued specific areas which were deemed to be fundamental to the aim of this research. Sprinklers unquestionably have a contribution to make with respect to their integration within a school's fire safety package. However, it will be for the 'Local Education Authorities' Departments to strike a balance between life-safety, cost, and property protection in order to safeguard the younger generations future.

In view of the aforementioned conclusion and analysis in respect to whether or not sprinklers should form part of a schools fire safety package, it is recommended that in order to reduce the excessively high number of school losses attributed to fire damage, Government should now legislate and actively encourage Local Education Authorities and all major stakeholders to introduce sprinkler systems as part of their fire safety package. Cognisance should also be paid to the fact that it is no longer socially acceptable to decide on their inclusion or otherwise, based on financial merit alone. Given the vast school-rebuilding programme outlined by the Government over the next ten to fifteen years, it is an ideal opportunity to safeguard the future and therefore every avenue should be thoroughly explored to ensure their inclusion.

In view of the installation 'cost – neutrality' status when balanced against construction savings, many Local Authorities now have sprinkler inclusion policies in place which cover all 'new build' whilst those who have not, actively encourage their installation.

This paper has been presented from the viewpoint of a Local Authority Building Control Surveyor. It is recommended that further research should be undertaken in

order to justify sprinkler inclusion as an active fire suppression method, not only from a property protection perspective but also from a life safety perspective.

REFERENCES

- Barlow, C (2006) *Early Day Motion 1726, Water Sprinklers in Schools*. Hansard <http://edmi.parliament.uk>
- Bickerdike Allen Partners, (1993) *Design Principles of Fire Safety*. London: HMSO.
- Building Bulletin 100 *Designing and managing against the risk of fire in school*. Department for Education and Skills 2004
- Carroll, T (2004) *Guidance on the Provision of Sprinklers in Schools*. The Chief Fire Officers Association.
- Chitty, R (2005) *Fire Engineering Seminar* Association of Building Engineers (ABE) Headquarters, Northampton, 10 October 2005.
- Fitzpatrick, J (2006) *Fire Safety* House of Commons Hansard Debate 01 March 2006: Column 148WH
- Fraser, B (2006) *Sorry we don't fit sprinklers* Western Mail & South Wales Echo Ltd, Sept 13, 2006 p.1
- Hall, B (2006) *Plans to reduce the risk of fire* South Wales Evening Post, March 23, 2006
- Hart, E. and Mackay, D (2006) *Arson Verdict Welcomed*. Press release, 10 October 2006. Mid & West Wales Fire Authority
- Information File (2006) *Sprinklers in schools*. British Automatic Fire Sprinkler Association LTD (BAFSA).
- Jones, I Graham, MS (2009) *The Integration of Sprinkler Systems into School Fire Safety Packages within South and West Wales*
- Milne, J. (2006) *Investing in Education - The Case for Installing Sprinklers in Schools* *Fire Prevention Fire Engineers Journal* November, pp 62-63
- Nash, P and Young, RA. (1991) *Automatic Sprinkler Systems for Fire Protection* 2nd Edition, Paramount Publishing Ltd.
- Pickard R. (1993/4) *Fire safety and Protection in Historical Buildings in England and Ireland- Part 1. Structural Survey* **12**(2), 27-31.
- Ryder, J. (2006) *New labour must fund Fire Sprinklers in Schools* Plaid Cymru, Western Mail (Cardiff) May 2006, p 13
- Sinnott, S. 2005. *Fire Sprinklers Save Schools* National Fire Sprinkler Network & European Fire Sprinkler Network, 07 September 2005.
- Stollard P, Abrahams J, (1999) *Fire from First Principles: A design Guide to Building Fire safety*. 3rd ed. E & FN Spon.
- Stollard P, Johnston L, (1993) *Design Against Fire: An Introduction to Fire Safety Engineering Design*. E & FN Spon.
- Zurich Municipal 2005. *A Guide to Fire Protection. Protecting Our Future - Looking After Our Schools*. Zurich Municipal
- Zurich Municipal 2005. *The Design and Protection of New School Buildings and Sites*. Zurich Municipal