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Slim profile double glazing in listed buildings

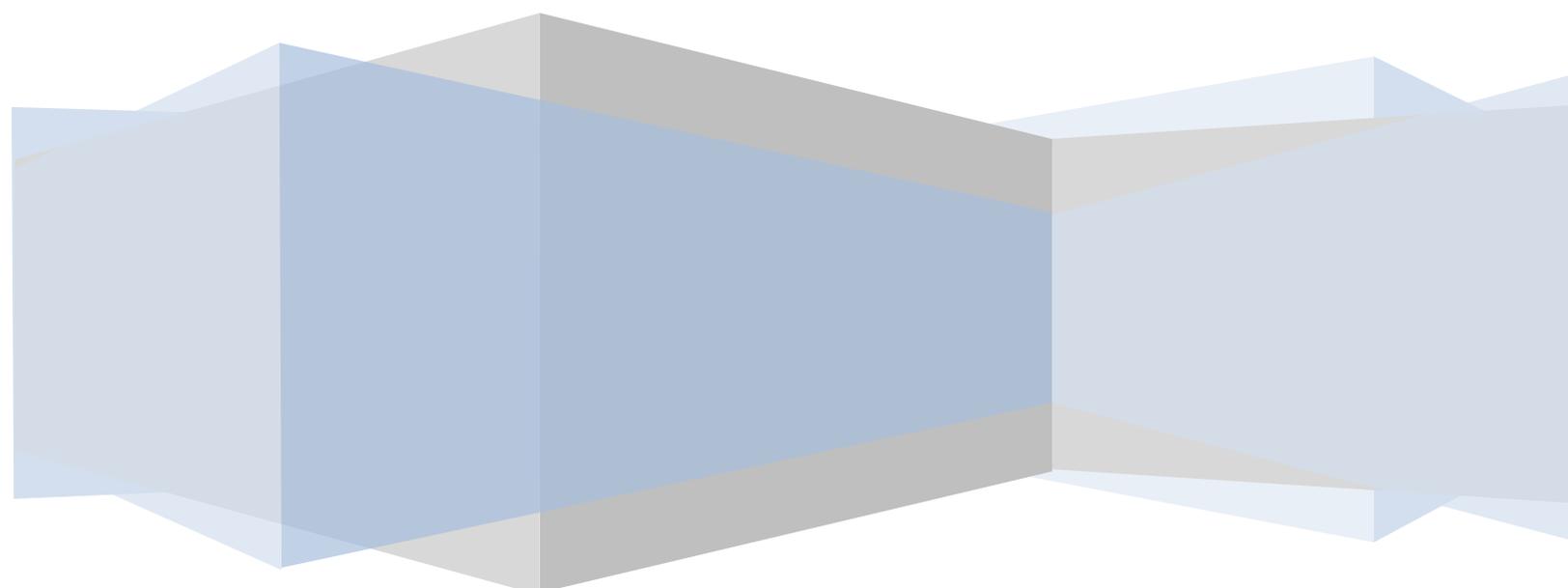
Research to identify the attitude and approach of conservation officers across the UK

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September 2015



Abstract

Listed and historic buildings need to improve their energy efficiency and ensure they do not become unaffordable luxuries. The options for reducing heat loss in listed buildings are constrained by traditional construction techniques and conservation requirements. The use of slim profile double glazing is one option that many listed building owners are keen to utilise but its use depends on whether local authorities (on the advice of conservation officers) are prepared to sanction it. This research investigates the attitude and approach of conservation officers across the UK to the use of slim profile double glazing in listed buildings. It looks at the similarities and differences in approach across different local authorities and regions and how guidance issued by government heritage agencies is applied in practice. The research was carried out in England, Scotland and Wales using an electronic questionnaire and semi-structured interviews of conservation officers and desk analysis of local authority planning application databases. The research found that the use of slim profile double glazing (SPDG) in listed buildings is becoming more common and that a majority of conservation officers are prepared to sanction it within certain boundaries. It found that across the UK there are considerable variations in approach between conservation officers ranging from those who firmly oppose it; to those who tentatively support it; to those who see it as a positive development. The results show that conservation officers tend to follow the guidance issued by government heritage agencies closely. There is evidence that Scottish conservation officers are more receptive to the use of slim profile double glazing in listed buildings than their English or Welsh counterparts and this is most likely a result of Historic Scotland's pragmatic approach towards conservation and energy efficiency and their willingness to undertake early research into double glazing in the context of traditional windows. Historic England have recently produced new guidance which is more supportive of slim profile double glazing and there is evidence that some English and Welsh conservation officers are becoming more receptive to its application in historic buildings. The research found that the fitting of slim profile double glazed glass into traditional window frames is a more common procedure in Scotland than in England or Wales and has resulted in retention of historic joinery. The data revealed that a common problem in England is the preference of joinery companies to manufacture new windows rather than undertake on-site repairs to existing windows or to retrofit slim profile double glazed glass. Several recommendations are made including the need for local authorities to publish guidelines setting out their approach to slim profile double glazing in listed buildings and conservation areas; more support for the retrofitting of SPDG glass into existing windows; tax incentives that prioritise repair and retrofitting over wholesale window replacement; and improved communication between conservation professionals, energy efficiency stakeholders and the glazing industry.

Acknowledgments

I would like to thank the following people for helping with this research project:

Representatives from Historic England, Historic Scotland, Cadw, the Society for the Protection of Ancient Buildings and the Sustainable Traditional Buildings Alliance for their willingness to impart their knowledge.

All the conservation officers and heritage team members who took the time to complete my questionnaire and who contributed so thoroughly through their further comments and emails. I would particularly like to thank those conservation officers who agreed to be interviewed.

Birgit Painter, my tutor, who guided me so positively and who always made me feel confident in my abilities after coming off the phone to her.

Jan Wiejak for his help with statistics.

My husband and children for their patience and encouragement.

Number of words: 25,137

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Glossary of terms

Cadw	The historic environment service of the Welsh government responsible for the protection of the historic environment and heritage sites of Wales.
Casement windows	Windows that are attached to the frame by one or more hinges. They are hinged at the side and can be used singly or in pairs.
Conservation area	An area of special architectural or historic interest, the character or appearance of which it is desirable to preserve or enhance.
Conservation officer	A specialist who works for a local authority reviewing and advising on listed building and conservation area consent applications.
Circular 61/96 of the Welsh Office	Circular that sets out advice on legislation and procedures relating to historic buildings and conservation areas in Wales.
Green Deal	A government policy launched by the Department of Energy and Climate Change in 2013 to permit loans for energy saving measures in UK properties which get paid back through savings in energy bills.
Heritage Agencies	Historic England, Historic Scotland and Cadw
Historic England	A non-departmental public body of the British government that protects the historic environment of England by preserving and listing historic buildings, ancient monuments and advising central and local governments.
Historic Scotland	An executive agency of the Scottish government responsible for the preservation and enjoyment of the historical environment of Scotland.
Leaded lights	Decorative windows, usually of a casement style, consisting of small sections of glass supported in lead cames.
Listed building	A building that has been placed on the statutory list of buildings of special architectural or historic interest. It may not be altered, extended or demolished without special permission from the local planning authority or the Secretary of State.

Low emissivity glass	Glass that has been specially coated to reduce heat transfer from the internal to external environment.
National Planning Policy Framework (NPPF)	Published in 2012 which consolidated over 24 planning policy statements and planning policy guidance notes.
Part L Building Regulations	Building regulations ensure that policies set out in legislation relating to building works are carried out. Part L controls all aspects of building works concerned with the conservation of fuel and power in England and Wales
Part 6 Building (Scotland) Regulations 2004	Building regulations in Scotland that ensure buildings are safe, efficient and sustainable. Part 6 deals with Energy consumption and conservation.
Planning Inspectorate	Amongst other duties, the Planning Inspectorate is responsible for deciding listed building consent applications under appeal.
Planning (Listed Buildings and Conservation Areas) Act 1990	An Act of Parliament that altered the laws on the granting of planning permission for building works, most notably on listed buildings in England and Wales.
Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997	An Act of the Scottish parliament that altered the laws on the granting of planning permission for building works, most notably on listed buildings in Scotland.
Sash windows	Windows made of one or more movable panels which can slide either vertically (most common) or horizontally. Traditional sash windows have the weight of the glazed panel balanced by counter-weights concealed in the window frame.
Slim profile double glazing (SPDG)	Double glazing with a cavity width of between 3 and 8 mm and designed specifically for use in traditional style windows.
SPAB	The Society for the Protection of Ancient Buildings founded by William Morris which campaigns, trains and offers advice on the protection of historic buildings. It has to be notified of any application to demolish a listed building in England or Wales

1 Introduction

The energy used in homes accounts for over a quarter of the carbon dioxide emissions of the United Kingdom and more energy is used in housing than in either transport or industry (Palmer and Cooper, 2012). It will be impossible to meet the emissions reductions set by the 2008 Climate Change Act without significantly changing emissions from homes. Given that 85% of homes in the UK will still be standing in 2050 (when total emissions need to have fallen by 80%) attention needs to intensively focus on the energy efficiency of the UK's existing housing stock (Killip, 2008). Listed buildings form a small but extremely important part of the nation's housing bank and given their protected status are all likely to be standing in 2050. The energy efficiency of listed buildings cannot be ignored because if they are exempted whilst improvements are made to unlisted housing stock then they will soon become uneconomic and risk falling vacant and into disrepair.

There is a wide body of research into improving the energy efficiency of traditional buildings. There is less research specifically into listed buildings where maintaining the balance between conservation, energy efficiency and structural integrity is crucial and complex. The options for reducing heat loss in listed buildings are restricted by the need to preserve the aesthetic qualities that make the building special. For instance, internal and external wall insulation is rarely possible or desirable; roof insulation is often hampered by the presence of lath and plaster; and floor insulation is prevented by the presence of traditional floorboards and flagstones. For this reason, windows are a focal point for reducing heat loss and improving thermal comfort levels. As a result, the glazing industry has developed a form of slim double glazing that can either be accommodated into existing window frames or fitted into new windows that replicate the style of the traditional windows they are replacing.

The utilisation of slim profile double glazing (SPDG) in listed buildings is controlled by the development teams of local authorities who are usually advised by conservation officers. The government agencies responsible for historic buildings in England, Scotland and Wales (Historic England, Historic Scotland and Cadw respectively) issue guidance on how traditional windows can be made more energy efficient but there is a lack research into how this guidance is interpreted in practice by conservation officers. This research project aims to fill this gap and discover what conservation officers feel about SPDG in listed buildings, whether there are different approaches between local authorities and how closely guidance is adhered to.

This project has value because it provides feedback to Historic England, Historic Scotland and Cadw (the Heritage Agencies) as to whether their guidance is utilised and applicable. It also helps reveal solutions to the potential conflict between historic conservation and energy efficiency improvements. One benefit of the research which only came to light once conservation officers had started to complete the survey, was that it enables them to compare their approach and attitude to SPDG to each other. Numerous requests were received for completed copies of the research to be emailed out.

The background section of this project covers all the technical aspects of energy efficiency in listed buildings, the legislative and policy framework, the specifics of slim profile double glazing and a review of the current literature which is not extensive. The methodology section sets out the quantitative and qualitative methods used to gather data. The primary source of data was an electronic questionnaire sent out to conservation officers. Semi-structured interviews added depth and understanding to the survey data. Analysis of local authority planning application databases provided concrete evidence of decisions surrounding SPDG in listed buildings and performed a triangulation function. The results are represented in seven sections and the data from all three methods is combined and analysed together. The sections are designed so that the objectives of the research are met. The main forms of data representation are pie charts, bar graphs and tables containing the results of statistical analysis. A discussion section interprets the results and identifies trends in the attitudes of the conservation officers who responded, draws conclusions about how and why the approach differs between conservation officers in England, Scotland and Wales and summarises the variations in guidance from the Heritage Agencies. The project concludes with recommendations about what could be done to utilise SPDG more fully in listed buildings and suggestions for further research.

2 Aim and Objectives

The aim of this research is to identify the attitudes and approaches of conservation officers across the UK to the use of slim profile double glazing (SPDG) in listed buildings.

To meet this aim, three objectives have been identified.

- To research the attitudes of conservation officers in the UK to the use of SPDG in listed buildings.
- To compare the response of conservation officers to SPDG in listed buildings to the guidance issued by Historic England, Historic Scotland and Cadw (the Heritage Agencies)
- To assess whether and how the approach to SPDG in listed buildings varies between different local authorities.

3 Background

3.1 What is a listed building?

A listed building is one which has been identified as having particular architectural and/or historic value. Registers of listed buildings are maintained by Historic England, Historic Scotland and Cadw. A building will be listed if it contains features of special interest in terms of design, decoration, craftsmanship, group value or associations with the nation's social, economic, cultural or military history.

Some listed buildings are designated as being of greater value than others. In England and Wales they are categorised as being either Grade I, Grade II* or Grade II with Grade I being of the most significant interest. In Scotland they are categorised as being either Category A, B or C with Category A being of national or international interest and Category C being of more local interest. Table 1 below shows the number of listed buildings in England, Scotland and Wales:

	Total	Grade I/Category A	Grade II*/Category B	Grade II/Category C
England ¹	375,588	2.5%	5.5%	92%
Scotland ²	47,649	8%	50%	42%
Wales ³	30,000	2%	6.7%	92%

¹ Figures as at 2012 (Historic England, 2015)

² Figures as at 2013 (Historic Scotland, 2015)

³ Figures as at 2005 (Cadw, 2015)

Table 1: Listed buildings in England, Scotland and Wales and their categories

3.2 Energy efficiency and conservation

All over Britain, listed buildings are used as homes; offices; retail outlets; places of worship; student accommodation; places of learning; and tourist destinations. As a result they need to be heated and lit. In general, the older and larger a building, the more energy it consumes (Suhr and Hunt 2013a). The soaring cost of energy makes it vital that listed buildings can be efficiently heated and powered. This is important for those in both private and public ownership because if they are uneconomical to keep warm then they become unoccupied and fall into disrepair. In Scotland, the category of housing with the largest proportion of dwellings with a poor energy rating are those built before 1919 (Baker, 2008).

An improvement in the energy efficiency of listed buildings becomes even more important as the energy efficiency of non-historic building stock improves. If listed buildings do not keep pace with the falls in energy consumption of other buildings, then they become a liability and an unaffordable luxury. Energy efficiency in listed buildings, however, is complicated not only because it can harm the architectural features that make the building special but also because it can interfere with the complex construction techniques that were designed to keep the building structurally sound for generations.

3.2.1 The Green Deal and old buildings

In 2013, the Society for the Protection of Ancient Buildings ('SPAB') became concerned about some of the thermal improvements advocated by the Green Deal when applied to older buildings. The different construction methods deployed in pre-1919 buildings can make it detrimental to use standard, modern techniques and materials. For instance, the use of wall insulation on a solid wall with lime mortar can prevent the natural movement of moisture through it and lead to a build-up of damp and mould. The same applies to draughts, where the aim of making the building fabric as air-tight as possible is laudable in modern construction but can be misplaced in listed buildings which require air flow. A number of conservation bodies

including SPAB came together to form the Sustainable Traditional Buildings Alliance ('STBA) to put pressure on the government to change the 'one size fits all' nature of the Green deal and to require assessments to be done by assessors who understand old buildings (Garlick, 2014). There is still progress to be made but the amended approach has made it more possible for conservation bodies such as SPAB to support the application of energy efficient improvements in traditional and listed buildings.

3.2.2 Building Regulations and old buildings

Part L of the Building Regulations ('Part L') covers the conservation of fuel and power in buildings and applies to England and Wales. It only becomes relevant to listed buildings where they are being upgraded or extended. The energy efficiency requirements of existing dwellings are very different for listed and traditionally-constructed buildings than they are for unlisted buildings. Historic England note that for historic buildings "an appropriate balance needs to be achieved between building conservation and measures to improve energy efficiency if lasting damage is to be avoided, both to the building's character and significance and its fabric." (Historic England, 2011).

Regulation 21 of Part L grants an exemption for listed buildings and those within conservation areas from compliance with energy efficiency requirements, if they would unacceptably alter the character or appearance of the building. There are also special considerations for non-exempt buildings of traditional construction where they only have to improve their energy efficiency where 'reasonably practical.' In both cases, the regulations advise that Historic England guidance be taken into account when determining appropriate energy performance standards and that building control bodies defer to conservation officers (HM Government, 2010). Neither of these caveats are designed as blanket exemptions from energy efficiency improvements but, in reality, the difficulty of deciding at what point an alteration becomes unacceptable means that Part L improvements on historic buildings are hard to enforce if there is no inclination from the owners to make them. It is easy to see, therefore, how listed and traditionally constructed buildings and buildings within conservation areas might, over time, significantly fall behind existing dwellings on energy efficiency standards and become relatively significant contributors to carbon emissions.

Scotland has its own building standards, the Building (Scotland) Regulations 2004. Part 6 covers the conservation of fuel and power and offers flexibility to listed and traditional buildings as to how to achieve minimum standards. They are not, however, offered the same level of exemption as English and Welsh listed buildings. The Scottish Regulations place emphasis on improvements being "as close to the full requirements as is reasonably practicable, with regard to all circumstances, including expense," (Historic Scotland and Scottish Buildings Standards Agency 2007a). This places greater onus on those listed buildings undergoing renovation to be as energy efficient as possible and there is a requirement for

thermal improvements to be made in other areas to compensate for areas of poorer performance.

3.2.3 The National Planning Policy Framework and the Planning Act

The two main influences affecting alterations and improvements to listed buildings are the Planning Act 1990 and the National Planning Policy Framework ('NPPF').

The Planning (Listed Buildings and Conservation Areas) Act 1990 provides the legislative framework that protects buildings and areas of special architectural and historic interest in England and Wales. Buildings in Scotland are covered by a very similar framework - the Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997. These acts require that i) all works to a listed building that would affect its character are prohibited unless they have been authorised; and ii) authorisation is in the form of written consent either from the local planning authority or the Secretary of State (HM Government, 1990). All local authorities, in particular the conservation officers, are required, above all else, to consider applications to change a listed building in light of the impact on its historic character and fabric, as specified by the Planning Act.

The NPPF is a framework that greatly simplifies the complex planning system and has sustainable development as a golden thread running through it. Section 12, conserving and enhancing the historic environment is the part relevant to listed buildings and it puts particular emphasis on the need to enhance the significance of heritage assets and put them to viable uses consistent with their conservation (HM Government, 2012). The guidance notes to the NPPF state that conservation is an active process of maintenance and managing change and that to ensure heritage assets remain in active use and are valued it is likely that sympathetic changes will need to be made from time to time (HM Government, 2014a). The NPPF is obviously relevant to listed buildings but it only provides guidance and individual conservation officers attribute varying levels of significance to it when considering listed building consent applications.

Often listed building consent applications refer to the public benefit of reduced carbon emissions to justify energy efficiency improvements. It is quite common though for local authorities to insist that improved energy efficiency alone is not sufficient justification for alteration. In the NPPF's planning practice guidance it is made clear that a public benefit can "be anything that delivers economic, social or environmental progress," but it "should be of a nature or scale to be of benefit to the public at large and should not just be a private benefit," (HM Government, 2014b). This is a grey area and it is possible that if the carbon emissions of historic buildings remain high, particularly in relation to non-historic buildings, and as the severity of climate change increases then changes that are at present seen as only having private benefit may actually start to have public benefit.

3.3 Listed building consent applications

Any alteration or extension to a listed building requires listed building consent (sometimes planning permission is required as well) from the local authority or the Secretary of State. It is a criminal offence to make alterations without consent and can result in fines, imprisonment and enforcement action to restore the building to its former state. Local authorities deal with listed building applications in a number of different ways.

3.3.1 England

In some local authorities the conservation officer gets designated as the case officer for alterations to listed buildings. This means that they make the final decision on the application rather than the development control team. In these cases the decision as to whether to allow or refuse an application is very solidly focused on historic conservation. In other local authorities the conservation officer does not assume responsibility for the final decision – they act as a consultee to the development control team and their advice is sought but not always acted upon.

Local authorities have the power to decide on all alterations to Grade II listed buildings but they have to consult Historic England where Grade I and Grade II* buildings are concerned.

3.3.2 Scotland

Most planning authorities make listed building consent applications the responsibility of the development control team. They seek advice from their conservation officers but a planning official usually makes the final decision, which may sometimes be contrary to conservation recommendations.

Applications to alter Category C buildings are dealt with solely by the planning authorities whilst alterations to Category A and B buildings require Historic Scotland to be consulted.

3.3.3 Wales

Like Scotland, applications to alter listed buildings are usually the responsibility of the development control team which takes advice from conservation officers. Cadw has to be consulted on all applications associated with Grade I, II* and II buildings although some local authorities have been granted sole power to deal with Grade II buildings.

3.3.4 Conservation officers

Despite the variations in structure outlined above, conservation officers play a seminal role in determining whether the owners of listed buildings (as well as the owners of buildings in conservation areas) can improve the energy efficiency of their homes. Developments in the glazing industry and changes in attitude towards energy saving amongst historic home owners are fruitless unless local authority conservation officers are on side. This research tries to qualify how conservation officers perceive slim profile double glazing (SPDG) in listed buildings

and how it fits within their main priority of preserving the historic character and fabric of buildings of special interest.

Many conservation officers rely on the appeal system to confirm whether their approach to applications to alter listed buildings is reasonable or not. Appeals are taken up by the Planning Inspectorate who re-examines the case and decides whether to uphold or refute the original decision of the local authority. If conservation officers find themselves losing a number of appeals then this is usually their cue to adjust their approach.

3.4 Improving the thermal performance of historic buildings

Improving the thermal performance of historic, particularly listed, buildings is a juggling act between reducing heat loss from the external envelope of the building; safeguarding the processes of evaporation and air circulation that need to take place to maintain a dry and healthy environment within; and protecting the unique aesthetic qualities that make the building special.

The advice from building conservation bodies is to adopt an holistic approach and to use products and techniques that do not hinder the building's capacity to 'breathe'. Procedures that are considered relatively uncontentious are the fitting of roof and ceiling insulation (providing breathable materials are used) and the draught-proofing of windows and doors. In twentieth century houses one of the most effective ways of reducing heat loss is through internal and external wall insulation. However, in many older listed buildings wall insulation is not an option either because it risks altering the special character of the building or because it can upset the building's natural equilibrium. As Suhr and Hunt write "traditional solid walls pose huge questions when it comes to deciding on insulation, many of which remain unresolved. In some situations, wall insulation may be best avoided," (2013b).

With wall insulation invariably not an option, listed property owners look to windows to improve thermal performance, particularly where they are large and constitute a significant proportion of the building's envelope. The draught-proofing of windows is a common and very effective way of reducing air infiltration but it does not prevent heat loss through the glass by conduction and convection. Research undertaken by Edinburgh Napier University has shown that insulated shutters can reduce the U-value of a single-glazed window by 79% (Currie et al, 2014). However, shutters are only effective at night time and many shutters in listed properties have either been removed or were never fitted in the first place – often the ground floor windows had shutters for security reasons but the upper floor windows did not. Another problem that blights the windows of traditional buildings is condensation. Not only can this reduce the energy efficiency of the building by causing damp but it can also result in the joinery of the window being damaged through rot. Condensation is an increasing problem in traditional buildings because greater efforts to seal the building envelope, including the sealing of chimneys when wood-burning stoves are fitted, mean that water vapour generated from

within has nowhere to escape. Halliday writes in her paper on Indoor air quality in traditional buildings that “changes to building fabric in pursuit of energy efficiency can lead to a build up of pollutants and/or to excessive moisture levels in some circumstances,” (2009) which can have a damaging effect on human health. The English House Condition Survey found that 6% of pre-1919 buildings suffered from condensation or mould and 21.7% suffered from some form of damp. This is significantly higher than buildings built post 1919 (cited in Halliday, 2009).

Secondary glazing, where a supplementary pane of either single or double glazed glass is installed on the inside of an existing window, has been shown to be an effective way of reducing heat loss from windows without damaging historic fabric. It enables the original glass to remain in place, which is why many conservation bodies prefer it. However, it does have the disadvantages of producing an unsightly double register, particularly on multi-paned windows; being cumbersome to manoeuvre leading to lack of ventilation and poor indoor air quality; and sealing the building from draughts which can cause humidity problems as is the case with Swansea’s Guildhall (Powell Dobson, 2013).

For reasons of energy efficiency, condensation and improved comfort levels, most listed property owners are keen to use slim profile double glazing (SPDG), instead of single glazing, if their windows are in need of replacement or repair. There are also an increasing number of people who consider SPDG for their windows even if they are not in need of repair.

3.5 Window types

In their publication – Traditional Windows: their care, repair and upgrading – Historic England explain the significance of traditional windows:

“Windows are the eyes of a building – they let in light and give views out – and profoundly affect its appearance. In addition, traditional windows bear witness to the artistic, social, economic and technological developments of past ages,” (2014a).

Early windows consisted of small panes of glass held together by thin strips of lead set within side hung oak casements (leaded lights). As sheets of glass became larger it became possible to rebate them in timber glazing bars which saw the advent of the vertical sliding sash window. Early sash windows had thick, robust glazing bars holding as many as twenty-four panes of glass in place. By the Georgian era the ratio of glazing bar to glass had been reduced to a minimum to facilitate the transmission of as much light as possible into buildings. Many windows at this time were of a ‘six over six’ –pane configuration as shown in Figure 1.

As glass became cheaper and stronger in the Victorian era it enabled the number of glazing bars to be reduced further so that ‘two over two’ –pane and eventually ‘one over one’ –pane configurations (Figures 2 and 3 respectively) became commonplace. Timber sash windows continued to dominate the glazing market up to WW1 when metal crittal windows were invented. Finally, the first upvc windows were introduced into the UK from Germany in the late

1970s and quickly became popular for their low maintenance and ability to easily accommodate double glazing.



Figure 1: Georgian 'six over six' -pane window



Figure 2: Victorian 'two over two'-pane window



Figure 3: Victorian 'one over one'-pane window

3.6 Slim profile double glazing (SPDG)

SPDG is a form of double glazing where the cavity between the two glass panes is thinner than in conventional double glazed units. Typically the cavity in SPDG is between 3 and 8 mm wide whereas with standard double glazing it can be as wide as 16mm.

3.6.1 U-values

The thermal performance of SPDG is poorer than that of double glazing but significantly better than that of single glazing. The table below shows the thicknesses and U-values of different glazing types:

Glass type	Total glazing thickness including cavity	U-value (centre of pane)
Single glazing	4 - 6 mm	5.4 W/m ² K
Slim profile double glazing	8.2 - 16 mm	1 W/m ² K to 2.8 W/m ² K ¹
Normal double glazing	20 - 25 mm	1 W/m ² K to 1.6 W/m ² K
Secondary glazing	approx. 110 mm	1.7 W/m ² K

Source: Baker and Heath, 2010

¹Depends on width and contents of cavity. Average U-value for all the types of SPDG tested was 2.0 W/m² K.

Table 2: Glazing types – cavity thicknesses and U-values

Under building regulations, the required overall window U-value for the replacement of glazing in an existing residential building is 1.6 W/m²K but this does not apply to replacement glazing in listed buildings which are exempt from compliance with Part L (Part 6 in Scotland).

3.6.2 SPDG in an historic context

The importance of SPDG in an historic building context is that it can generally be fitted into existing window rebates designed for single glazing or into new windows that need to replicate an existing, traditional profile. Baker and Heath see SPDG as an opportunity to improve the thermal performance of the element of an historic building's envelope that performs worst thermally (2013) whilst providing an opportunity to retain the existing joinery or very closely replicate it. SPDG provides potential for heat loss reduction not just in the windows of listed buildings but also in buildings in conservation areas and other traditionally constructed buildings. Set out below are the main advantages and disadvantages of SPDG compared to single glazing in an historic building context:

3.6.2.1 Advantages

- a. Reduced heat loss through the glass. Depending on the type of SPDG used and the style of window replaced, the calculated heat loss reduction can be as high as 63% for Georgian style windows and 73% for Victorian style windows compared to their single glazed equivalents (Baker and Heath, 2010)
- b. Reduction in the energy consumption of the building. The extent of the reduction depends on the ratio of glass to wall area and the ratio of glass to glazing bar. Research by SPAB indicates that the heat loss from the walls of historic buildings may be up to 3 times less than the standard U-values used across the construction industry (SPAB, 2014). This is also backed up by research from Glasgow Caledonian University that shows that the walls of traditional building perform better thermally than would be expected from the U-value calculations of software programs (Baker, 2011). If this is the case then SPDG could have an even greater impact on the overall thermal performance of historic buildings.

- c. Reduction in the carbon emissions of historic buildings.
- d. Reduced internal condensation on windows which can increase the lifespan of the window frame.

3.6.2.2 Disadvantages

- a. SPDG can result in the loss of historic glass which is not only beautiful but also records growing trends of affluence; new skills in workmanship; government policies; and changing architectural styles over the centuries.
- b. The windows and the glass within them are often the element of special interest and altering them can have a detrimental effect on the character of the building or on the group value of a set of buildings.
- c. It is not clear as to the longevity of SPDG and one criticism often cited is that a material with a lifespan of possibly only 25 years is replacing something that can, providing it's not broken, last for many hundreds of years. This has obvious economic and environmental repercussions. SPDG units are now manufactured with 10 year guarantees in place but they have not been around for long enough to know whether they will have lost their efficacy in 25 years time.
- d. The use of some inert gases in SPDG results in the window never being able to save as much energy as went into its manufacture. Cradle to site analysis of SPDG by Menzies and Heath has shown that windows filled with 100% xenon have an extremely high embodied energy which can never be recouped during the operational phase of the window (2010). However, the more common practice is to either use lighter gases such as argon or krypton or a mixture containing xenon. In these cases, Menzies and Heath found that the embodied energy could be repaid many times throughout the life of the window due to its improved thermal performance (2010).
- e. The spacer material between the two panes of glass in an SPDG unit means that it is much harder to recycle than single glazing.

3.6.3 Recent developments in SPDG

The SPDG market is constantly changing and it is difficult for conservation officers to keep up to date with new developments. Continual refinement of the product may, however, make the difference between it being acceptable or unacceptable in heritage terms. Below is a list of recent innovations:

- An ultra clear low-emissivity glass, which improves light transmission, is now available and was developed to counteract criticism of the visible tint from normal low-e glass.
- Vacuum-filled cavities of less than 2mm which dramatically reduces the depth of the rebate and the width of the glazing bar.
- In some makes of SPDG, the perimeter seal of the unit has been reduced to 5mm which has enabled narrower glazing bars (typically 18mm in width) to be used. By comparison, the typical width of a glazing bar accommodating single glazing in a Victorian sash window is 12mm although many other glazing bars are thicker (Historic England, 2014a).

- Some companies are able to satisfy all 6 parts of BS EN 1279 in relation to their SPDG units – this helps to give greater assurances over longevity.
- White and grey spacer bars (as well as black) are available so that they are less noticeable against the colour of the timber frame.
- New methods of glass manufacture mean that the outer pane of the SPDG unit can be given distortions that help reduce the flat, mirror-like reflection that is a common criticism of SPDG. SPDG can now compose of hand drawn, cylinder or machine drawn glass.

3.7 The Heritage Agencies' approach to SPDG

Historic Scotland, Historic England and Cadw are the agencies of government that are responsible for listed buildings in the UK. One of their responsibilities is to facilitate research and issue guidelines on how best to preserve and improve listed buildings to secure their existence. Many conservation officers refer to this research/guidance to inform their decisions on listed building consent applications. Part of this project is to investigate the extent to which conservation officers apply this guidance in relation to windows. A review of relevant guidance and research documents is set out below.

3.7.1 Historic Scotland

3.7.1.1 *Conversion of Traditional Buildings: A Guide for Practitioners*

Historic Scotland and the Scottish Buildings Standards Agency (SBSA) have produced a joint publication on how to meet current building standards whilst maintaining historic integrity (2007a). Energy efficiency improvements are a strong thread running through the guidance and the emphasis is on adapting them to suit the needs of historic buildings rather than giving practitioners an excuse to avoid them. As the guide notes, conversion of historic buildings “is one of the triggers for the application of building standards that seek to achieve a number of social benefits, ranging from better disabled access and egress to a reduced carbon footprint across this small country,”(Historic Scotland and SBSA, 2007b).

The advice in relation to traditional windows is that if they are important to the character of the building then their qualities should not need to be compromised to meet building regulations, as long as improvements in thermal performance are made in other areas to compensate. Where windows need to be replaced, then the advice is to:

- respect the design of the originals;
- use single-glazing if it's necessary to maintain the character of the building but make sure improvements are made such as draught-proofing, use of shutters or secondary glazing; and
- use double glazing where the window style can accommodate it which is usually in 'one over one' or two over two' -paned windows and some multi-paned windows with thicker glazing bars.

It is significant, that even back in 2007, before technical research on the efficacy of SPDG had been conducted, Historic Scotland were open to its application in historic buildings.

3.7.1.2 Managing change in the historic environment - Guidance notes: Windows

In this guidance, Historic Scotland advocate repair ahead of replacement and encourage draught-stripping, shutters and secondary glazing as means of improving energy efficiency (2010a). However, there is a marked difference in their attitude towards double-glazing compared to Historic England's at a similar time.

Within the key issues, the guidance says "double-glazing may be acceptable either where the existing windows are beyond repair and the new windows will match the original joinery, or where it can be incorporated within the original joinery," (Historic Scotland, 2010b). Historic Scotland's support for SPDG in historic buildings demonstrates a strong commitment to energy efficiency, which is particularly important where winters can be so cold. The guidance does not sanction the loss of historic glass and where there is no alternative other than to replace a window then it advocates the retention and reuse of historic glass.

Historic Scotland's early support for the retrofitting of SPDG in existing windows has meant that it is a common procedure in Scotland (particularly in Edinburgh) and that there are plenty of joinery companies skilled at undertaking this type of work.

3.7.1.3 Technical papers on the performance of SPDG

Between 2010 and 2013 Historic Scotland commissioned research by Glasgow Caledonian University which measured the in-situ U-values of Georgian and Victorian sash windows fitted with different types of SPDG (Baker et al, 2010, 2013). In some cases the windows were entirely new whilst in others the existing window frame was retrofitted with SPDG. The types of SPDG varied according to the width of the cavity and its content. Further research was undertaken 2 years later to see if the U-values had deteriorated. The important findings for the purposes of this project were that:

- the total heat loss reduction of sash windows fitted with SPDG compared to single glazing ranged from 35% (cavity filled with air) to 63% (cavity filled with a vacuum). This compares to a heat loss reduction of around 60% for secondary glazing.
- SPDG performed better when fitted into Victorian sash windows with either a 'one over one' or 'two over two' -pane configuration, than when fitted into Georgian 'six over six' -pane windows due to less thermal bridging.
- The best performing gas-filled SPDG achieved better thermal performance than secondary glazing in 'one over one' -pane Victorian windows but not in multi-paned windows.
- Re-measurement 2 years later did not yield conclusive results but showed there was either no deterioration or a small deterioration in U-value.
- The embodied energy of all the SPDG units (with the exception of those using xenon) could be repaid many times throughout the expected life of the unit.

The findings from this research have been interpreted in different ways by planning, conservation and heritage bodies. Some organisations, such as SPAB and Historic England (until recently) interpreted it as showing that SPDG offers no greater thermal performance benefits than secondary glazing and should not be encouraged (Historic England, 2011). Historic Scotland was quick to endorse the research and agreed that SPDG could be acceptable in listed buildings, in some circumstances (Historic Scotland, 2010a). For the City of Edinburgh council, the research was conclusive enough to lead to a city-wide change in planning guidelines in 2010 to allow SPDG (with cavities no wider than 6mm) in listed buildings providing there is no loss of historic glass (City of Edinburgh Council, 2010).

Conservation officers also interpret this research in various ways as this dissertation will show. There are those who are fairly comfortable with the concept of SPDG in listed buildings whilst others feel that its benefits are not significant enough to warrant its replacement of single glazing.

3.7.2 Historic England (formerly English Heritage)

3.7.2.1 Energy efficiency and historic buildings

This guidance written by Historic England explains how Part L of the building regulations applies to historic and traditionally constructed buildings (2011). It aims to encourage energy efficiency improvements providing they do not damage the character or long-term health of the building. It makes clear that exemptions granted to listed buildings are not unconditional but, unlike the Scottish regulations, there is no reference to minimum standards nor to compensatory thermal improvements in other areas. Double glazing gets a short mention but there is a general reticence about its accommodation into existing frames (retrofitting) and no reference to its thermal qualities vis-à-vis single glazing.

It is possible that Historic England's hesitancy in offering support to the retrofitting of slim profile double glazing has been a factor in creating an SPDG industry in England and Wales that predominantly supplies the new window market.

3.7.2.2 Traditional windows: their care, repair and upgrading

In 2014 Historic England produced a detailed guidance paper on traditional windows (2014a). This sees them adopting a more conciliatory approach to SPDG in historic buildings and one which is more closely aligned with that of Historic Scotland. They promote the use of non-invasive methods to control heat loss through windows on the grounds that they can be as effective as double glazing but, in contrast to their earlier publication, they do cover SPDG in detail and recognise its contribution to enhanced thermal performance. They advise that SPDG may be appropriate in historic buildings in the following circumstances:

Replacement glass:

- If there is no historic glass present.
- Where the glazing rebate is deep enough, which is more likely to be the case for simple casement windows or 'one over one' –paned windows.
- Where the window is a sympathetic replacement.
- In steel windows where the rebate is deep enough.

They continue to be wary of SPDG being fitted to multi-paned windows and to very old timber sashes where the additional weight may cause damage to the frame.

Replacement windows containing SPDG:

- Where the old window has been deemed irreparable by a conservation officer and the new window can closely match the profile of the original window.
- Where an inappropriate window is being replaced by a new one which is more in keeping with the period of the property.

Unlike Historic Scotland, Historic England caution that “the cost of double glazing will seldom be covered by energy savings within the lifetime of the insulated glazed units,” (Historic England, 2014b); that secondary glazing can be more effective in preventing heat loss, particularly in the case of multi-paned windows; and that SPDG has a limited lifespan with a risk of condensation forming in the cavity.

3.7.3 Cadw

Cadw has tended not to issue its own guidance on traditional windows. In 2011 they published their Conservation Principles in Action which was a high level strategy as to how conservation can be integrated with other interests and how change can be incorporated into historic assets (Cadw, 2011). Although there is no specific mention of windows the guidance recognises that in some cases natural heritage values cannot always prevail and as a result, part or all of some historic assets may be lost.

Circular 61/96 of the Welsh Office published in 1996 covers double glazing in listed buildings. It advises that it's, “impossible to install double glazing into existing frames or to replicate traditional windows using double glazing without making drastic changes to the shape and proportions of glazing bars,” (Welsh Office, 1996). This advice is clearly out of date and, as a result, conservation officers in Wales rely heavily on guidance issued by Historic England and Historic Scotland.

4 Methodology

4.1 Initial planning

Understanding the attitude of conservation officers to SPDG is crucial because they are so important in determining its use. The initial proposal was to pose open-ended questions, during structured interviews, to a selected number of conservation officers. Emails were sent to conservation officers across the South East and South West. The response rate on this basis was extremely low and after discussion with a number of them it became clear that, because of the nature of their job (many of them work part-time and spend time on site visits), they are unable to commit to an interview or dedicate time in the day to answering open-ended questions. It was, therefore, decided that in order to achieve a meaningful response rate, the questionnaire would need to take no more than 30 minutes to complete; consist mainly of closed-ended questions; and be in web format so that it could be delivered electronically and completed outside of office hours.

To meet the objectives of the study it was decided necessary to use 3 methods of data collection:

- Survey;
- Desk research; and
- Semi-structured interview.

The survey was intended to produce quantitative data that could be analysed to form an understanding of the approach of conservation offices to SPDG in listed buildings. This data would then be used to draw conclusions about the similarities and differences in approach between conservation officers and about how guidance from the Heritage Agencies is interpreted in practice. It was hoped that the survey would be completed by enough conservation officers in England, Scotland and Wales to enable meaningful conclusions to be drawn about the approach to SPDG in these three different regions.

The desk research had two main purposes: to provide an additional source of data to compliment the survey data, a form of triangulation; and to identify and analyse the guidance issued by the different Heritage Agencies about SPDG in historic buildings.

Initially the interviews (to be conducted on conservation officers) were intended to produce qualitative data which the closed-ended questions of the survey could not achieve. In reality, however, the survey produced significant qualitative data because many respondents used the further comment field at the end of each question to expand on their response. In light of this, the interviews were used to fill knowledge gaps arising from the survey and to address new issues that the survey responses revealed as being significant. For instance, conservation officers were asked about the procedure used in their local authority to deal with listed building consent applications and whether building regulation officers were consulted.

Another question focused on whether they considered SPDG to be acceptable in modern extensions to listed buildings.

4.2 Quantitative data collection - Survey

4.2.1 Design stage

The questionnaire was developed using SurveyMonkey. A copy of the survey can be seen in the appendices. The information for participants, including ethical and data protection issues, were incorporated into the main body of the survey and respondents could only complete the survey if they had checked the consent box. The questionnaire took the form of 8 sections and consisted of 35 questions. When designing the survey, the following criteria were applied:

- The number of open-ended questions was kept to a minimum.
- No question required a response.
- For participants wanting to qualify their response, a 'further comment' field was added to each closed-ended question.
- All of the closed-ended questions (apart from two) were mutually exclusive making it impossible for respondents to check more than one answer.
- Some questions were designed to reveal attitude towards energy efficiency in listed buildings and SPDG, in particular. These had Likert four point agree/disagree scales with an additional 'don't know' field.
- Some questions were designed to extract factual information such as the number of SPDG applications over a given period; or whether conservation teams have produced guidelines on SPDG in listed buildings.
- Many of the questions were designed to reveal the general approach of a conservation officer to listed building applications to replace windows with SPDG. Most of these behaviour questions used a Likert three point frequency scale (never, occasionally, frequently) with an additional 'don't know' field whilst others used a Likert four point frequency scale of yes, in most cases, in a few cases or no.
- A ranking question was used to reveal the level of concern over different aspects of SPDG in listed buildings.
- At the end of the questionnaire there was an option to agree to a semi-structured interview.

The purpose of the survey was to obtain data that would help meet the objectives of the project which were to discover the attitude and approach of conservation officers to SPDG in listed buildings; find out whether there are variations in approach between different regions; and to compare what gets authorised at local authority level to what's being recommended at guidance level by the Heritage Agencies.

4.2.2 Pilot stage

The questionnaire was piloted on two conservation officers, an historical buildings surveyor and conservation specialists at Historic Scotland and Cadw. The purpose of piloting was to identify poorly worded or misconceived questions; to make sure that the questionnaire was

covering the most important issues; and to ensure that it was engaging enough for conservation officers to want to complete it. Given the uniformity of the target population, it was not felt necessary to pilot it on the general public.

The main changes made after piloting included removing a question that asked respondents to speculate on the reasons people use spdg in listed properties; adding a further option box to Question 34 which asks respondents to rank their concerns over the use of spdg in listed buildings; and adding Question 27 which asked conservation officers whether they ever specify that the external pane of glass in an spdg unit be made from handmade or historic glass.

4.2.3 Participants and dissemination

The aim was to get as many conservation officers from different local authorities to complete the survey as possible. It was particularly important to get a representative sample to respond from England, Scotland and Wales to carry out the comparison between conservation officers operating under guidance from the different Heritage Agencies.

Local authorities from the following regions were contacted for the email addresses of their conservation officers or heritage teams: South West, South East, West Midlands, East Midlands, East Anglia, North, North East, North West, London, Scotland and Wales. The survey was sent via email in batches between 18 March and 25 April. A single reminder email was sent out to non-respondents one week after the initial contact.

It was not possible to send the survey out to all local authorities because of time constraints but in order to achieve results representative of the UK, it was emailed to at least 10 local authorities in every region. The survey response rates were monitored and for regions where rates were low then other local authorities in that region were contacted. Despite this strategy, some regions such as the North East and North West are poorly represented due to only one conservation officer responding. Other regions, such as the South West and Scotland, are well represented due to 10 or more conservation officers completing the survey from these areas.

Where a local authority has more than one conservation officer then the survey was emailed to all of them to increase response rates. In these cases, some local authorities nominated one person to complete the survey whilst in others it would be completed individually. As a result, some local authorities have submitted responses from more than one conservation officer and are therefore well represented.

4.2.4 Processing and analysis of survey responses

A contacts database was set up to record details of those conservation officers sent a questionnaire. This was updated each time SurveyMonkey sent a notification that a questionnaire had been completed. It was used to ensure that reminder emails were not sent

to people who had already responded and to keep track of conservation officers who agreed to further contact and requested a copy of the finished research project.

SurveyMonkey automatically analyses response data but in order to carry out more in-depth analysis the data was exported to Excel where each survey question was given its own spreadsheet. Incomplete questionnaires were discarded. The survey was designed so that quantitative analysis could be easily performed on the majority of the questions by making them closed-ended. The response options for each question were coded numerically and a formula, using Excel's 'count-if' function, was used to add up the frequency of different responses. These were converted to percentages and depicted as pie or bar charts. As well as looking at the responses as a single group (UK), they were broken down into three sub-groups (England, Scotland and Wales).

Statistical analysis was performed using Excel's data analysis tool. The most useful outputs for this research were the mean, median and standard deviation and these were particularly revealing for Questions 5, 6, 9, 14 and 34. For the statistical analysis, the 'don't know' responses were filtered out because they created misleading distortions.

Once the data analysis was complete each question was studied to identify trends in conservation officers' approach to SPDG, particularly evidence of conformity or disparity in approach. The further comments were useful as a check to ensure that conclusions drawn from the quantitative data were not masking important realities. On some of the questions where the 'don't know' response was used a lot (for instance, Question 6) the further comments were important in obtaining a full picture of respondents' views. Some of the questions in the survey were carefully crafted to reflect guidance from the Heritage Agencies and the data from these were used to draw conclusions on how guidance is adhered to in practice. As well as identifying trends across the UK-wide group they were also identified within the three regional sub-groups to see if there were similarities and/or differences in approach between England, Scotland and Wales.

4.3 Quantitative data collection – desk research

4.3.1 Local planning authority databases

The Town and Country Planning Order (2015) requires local planning authorities to maintain an online register of planning and listed building consent applications in their area. The amount of data that local authorities store electronically associated with applications and consents is very extensive. Despite the ability to use advanced searches to filter information by date, key word etc., it became clear, early into the research, that there would be problems fully utilising the databases:

1. Each application/consent has a large number of documents (in some cases as many as 30) associated with it. Since all listed building applications are dealt with on a case by case

basis it is not possible to profile them effectively without studying each one in detail and this could not be accommodated within the timeframe.

2. The design and access statements accompanying each listed building consent application vary considerably in terms of the level of written and photographic detail. Again, this makes it difficult to profile cases successfully.

As a result, it was decided to use the local planning authority databases to investigate some of the themes evolving from the survey– a form of triangulation. One area where the databases could add validity to the survey data, was in providing specific examples of applications to use SPDG in listed buildings and the subsequent granting or refusal of consent. Another area was in confirming the differences in how SPDG is incorporated into windows in listed buildings between Scotland and the rest of the UK.

The following local authority databases were searched:

- Edinburgh City Council
- Basingstoke and Deane
- Bath and North East Somerset
- Cotswolds
- Vale of the White Horse
- Rushcliffe
- Westminster

On each of the above local authority websites a planning application search was conducted using ‘windows’ as the descriptive keyword; and ‘listed building consent’ as the application type. Applications to replace windows with SPDG were identified from the search results. It was not possible within the timeframe to record all such applications and therefore a few were selected to demonstrate themes emerging from the survey and to attempt to demonstrate the general approach of the local authority towards SPDG.

4.3.2 Recording database information

Very few listed buildings are the same and this means that consent applications to replace windows are extremely diverse. As a result, the recording and categorising of the data is difficult. It was decided that the best way to represent the data was as a series of case studies containing the following information:

- Approximate age of the building
- Listing category
- Details of the existing windows
- Details of the proposed window alterations
- The decision
- The explanation, in the case of a refusal.

4.4 Qualitative data collection – semi-structured interviews

Seventeen conservation officers indicated on the survey that they would be happy to be questioned further. Emails were sent out requesting suitable times for telephone interviews to take place. Seven conservation officers responded and interviews were carried out over the course of a two week period. Conservation officers from the following regions were interviewed – Scotland (2), Wales, East Midlands, London, South East and East Anglia.

4.4.1 Interview design

Like the desk research, the interview questions were designed to follow up on themes evolving from the survey. They were also used to clarify areas of confusion. Although similar questions were asked during each interview they were not standardised because different responses in the survey warranted different questions. During the course of the interviews the following issues were explored:

1. The procedure under which listed building applications are dealt with including:
 - a. whether the conservation officer acts as advisor to the development control team or is appointed case officer;
 - b. how often decisions are made that go against the advice of the conservation officer;
 - c. whether they visit the buildings where window replacement is being proposed.
2. The interaction between conservation officers and building control.
3. Whether owners replace windows in listed buildings without consent.
4. Further discussion surrounding their opposition to or support of SPDG.
5. Examples of SPDG being installed in notable buildings in their local authority area.
6. Further discussion as to why SPDG has been embraced in some regions but not in others.
7. Their approach to SPDG in the modern extensions of listed buildings.

5 Results

5.1 Survey response rates

The survey was emailed to 200 conservation officers and heritage teams across the UK. 56 conservation officers responded with 52 surveys fully completed and 4 partially completed which were subsequently excluded. The response rate based on the completed surveys was 26%. Table 3 breaks down the responses according to region.

	Responses	Region	Responses
England	35	London	4
		South East	7
		South West	10
		East Anglia	3
		East Midlands	2
		West Midlands	4
		North	3
		North East	1
		North West	1
Scotland	9		
Wales	8		
Total	52		

Table 3: Number of survey responses according to region

5.2 Attitudes towards energy efficiency in listed buildings

Questions 5 and 6 of the survey asked respondents:

Q5 Whether they considered energy efficiency to be an important issue in listed buildings.

Q6 Whether they considered slim profile double glazing to be an important factor in improving the thermal performance of listed buildings.

Figure 4 shows that 90% of the respondents either agreed or strongly agreed that energy efficiency in listed buildings is important. Four of them qualified their answer by adding that it can be achieved in many different ways and a further three noted that it should be considered in the context of the building's capacity to accommodate change. One respondent said the following, "I think owners would like [listed buildings] to be more energy efficient for cost savings on fuel and internal comfort, however, there needs to be a balance between what is right for the building, in terms of performing to its own needs, and that of the modern owner who seeks improvements that the building was not necessarily designed to cope with."

Four respondents disagreed and one strongly disagreed to Question 5. For those disagreeing, a few commented that they felt energy efficiency should not be an overriding concern for this segment of the nation's building stock. One conservation officer, during interview, said that listed buildings represent such a small proportion of the country's building stock that their energy efficiency should be irrelevant.

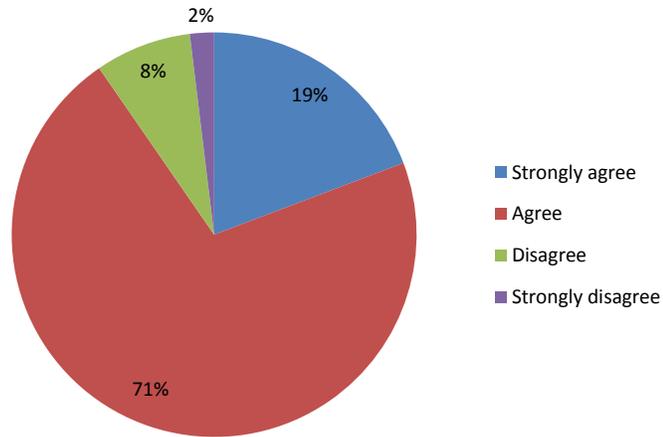


Figure 4: Total responses to Question 5

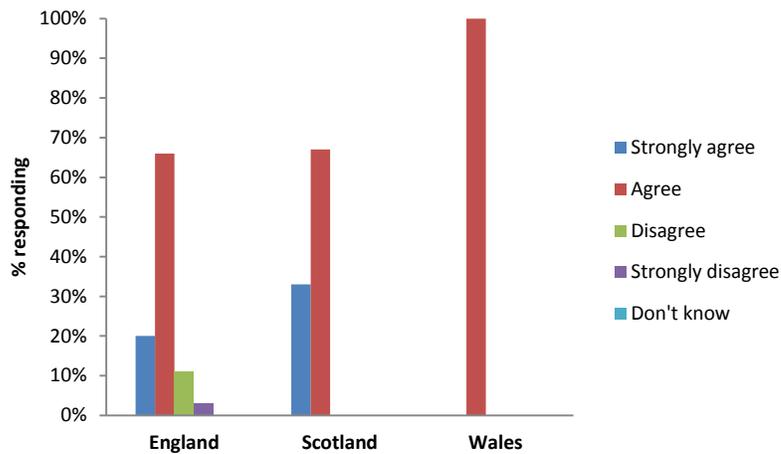


Figure 5: % responses to Question 5 according to region

Figure 5 shows the percentage responses according to whether the conservation officer is operating in England, Scotland or Wales. All conservation officers in Scotland and Wales either agreed or strongly agreed that energy efficiency is important in listed buildings. All those respondents who disagreed (5 in total) were from England.

Figure 6 represents the results from Question 6 and shows that there is disagreement amongst conservation officers about the importance of SPDG as a means of improving the thermal performance of listed buildings. 46% of all respondents agreed that SPDG is an important factor in improving thermal performance, whilst 39% disagreed and 15% answered 'don't know'. The 'don't know' option is interesting because, out of the eight people who used this

option, six of them explained in the comments box that they were using it to indicate that they felt there were valid arguments both for and against its use.

This question received a lot of comment mainly to do with the effectiveness of SPDG. There were comments that the energy reduction does not always outweigh the costs of installation; that there are other options that don't destroy historic fabric and have a greater impact on overall thermal efficiency; and that there is a common perception amongst owners of listed buildings that SPDG will have a disproportionate effect on the thermal performance of their property. For one conservation officer, this question was problematic because on the one hand he recognised the significance of SPDG in improving thermal performance but on the other he did not feel that it was appropriate in pre-twentieth century listed buildings and therefore never sanctioned its use.

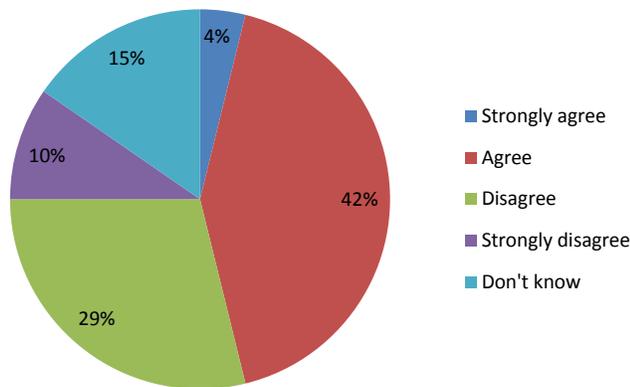


Figure 6: Total responses to Question 6

Figure 7 shows that there is more opposition to SPDG amongst surveyed conservation officers in England than there is in either Scotland or Wales. In England, more respondents disagreed with Question 6 (45%) than agreed (40%); whilst in Scotland 22% disagreed and 56% agreed; and in Wales 25% disagreed and 63% agreed. All four conservation officers who strongly disagreed with Question 6 were from England. In Scotland and Wales the percentage of people indicating 'don't know' reflected the opinion of three people. In all three instances the use of the option did not indicate that they didn't know the answer but that they neither agreed nor disagreed, either because they feel SPDG should be combined with other energy saving measures or because they believe the costs of installation outweigh the energy savings.

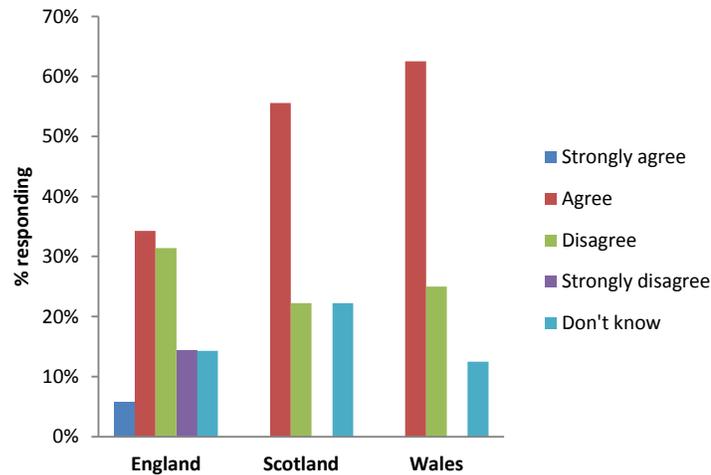


Figure 7: % responses to Question 6 according to region

Statistical analysis comparing the responses to Questions 5 and 6 produced the results set out in Table 4 below. Table 5 shows how the responses were coded. For these purposes, those respondents who indicated ‘don’t know’ were excluded.

	Q5	Q6
Mean	1.92	2.52
Standard deviation	0.59	0.76
Median	2	2
Mode	2	2
Count	52	44

Response	Code
Strongly agree	1
Agree	2
Disagree	3
Strongly disagree	4

Table 4: Statistical analysis of Questions 5 and 6 Table 5: Response codes, Questions 5 and 6

For Question 5 the mean is very close to 2 (agree) whilst for Question 6 it is 2.52 (between the agree and disagree options). The higher standard deviation of the responses for Question 6 shows that there is less consensus amongst conservation officers that SPDG is a good way of improving the thermal performance of listed buildings compared to fairly uniform agreement that energy efficiency is an important issue.

5.3 Trends in the use of SPDG in listed buildings

Questions 8 and 9 were designed to investigate conservation officers’ perceptions of the use of SPDG in listed buildings. Respondents were asked:

Q8. Whether they have seen an increase over the past five years in the number of consent applications to replace windows in listed buildings with SPDG.

Q9. How many listed building consent applications they receive to replace windows with SPDG units over a six month period.

Figure 8 shows that all the conservation officers surveyed (apart from six who indicated that they didn't know) have experienced some increase in SPDG applications. 67% have experienced a small increase whilst 21% have experienced a significant increase. Two of the respondents who ticked the 'don't know' box commented that they had been in their role for less than five years but in that time they had received a constant flow of SPDG applications. If the responses are separated according to region, it reveals that 33% of the surveyed conservation officers in Scotland have experienced a significant increase compared to 20% in England and only 13% in Wales.

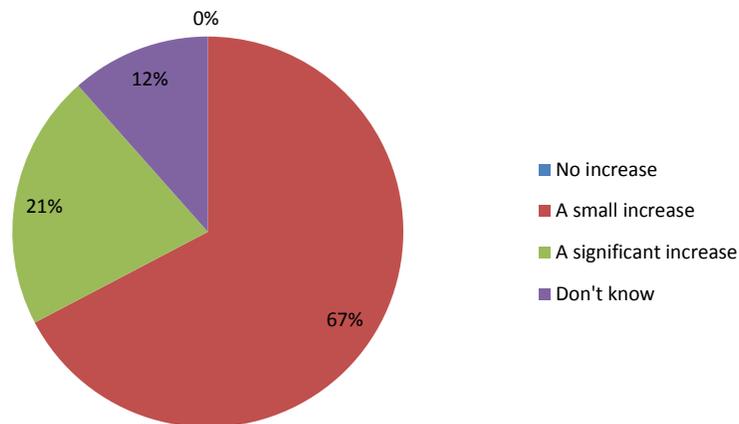


Figure 8: Total responses to Question 8

Question 9 asked conservation officers how many SPDG applications they receive every six months. The results are not the actual number of applications received but estimates of SPDG applications according to respondents. It is interesting to note that three conservation officers from the same local authority gave different responses to this question.

As a checking process, searches were conducted on the planning databases of two local authorities where the conservation officers estimated a high number of SPDG applications. For the period from 1 October 2014 to 1 April 2015 one local authority received four SPDG applications whilst the other received five. Conservation officers from these areas, however, estimated in the survey that they received more than twenty in a six month period. It is possible that when answering Question 9, respondents were including pre-application enquiries as well as formal applications in their answer but either way it seems that the results to Question 9 should be treated with caution.

Table 6 shows the results of statistical analysis performed on the responses to Question 9. It shows that the mean response from the whole sample was 2.75 indicating that, on average, respondents receive between five and ten applications to replace windows with SPDG every six months. When the responses are separated according to region, the mean responses for

England and Scotland are similar and remain closest to the ‘between five and ten’ category. The mean for Wales, however, is 2.25 indicating that most of the Welsh conservation officers receive less than five SPDG applications every six months. The higher standard deviation for England denotes that there is a wide spread of responses across the answer spectrum - six conservation officers indicated that they receive between ten and twenty applications every six months and a further two said they receive more than twenty. The standard deviation for Wales, however, is much smaller and denotes a narrow spread of responses – all the Welsh respondents said they either receive less than five applications every six months or between five and ten.

	Responses - Total	Responses - England	Responses - Scotland	Responses - Wales
Mean	2.75	2.9	2.86	2.25
Standard deviation	0.89	0.96	0.90	0.46
Median	2.5	3	3	2
Mode	2	2	2	2
No. of responses ¹	44	30	7	8

¹Excluding respondents answering ‘don’t know’.

Table 6: Statistical analysis of Question 9

Response	Code
None	1
Less than five	2
Between 5 and 10	3
Between 10 and 20	4
More than twenty	5

Table 7: Response codes, Question 9

There were a number of interesting comments made about Questions 8 and 9. One conservation officer noted that some people obtain consent to replace their windows with SPDG but then decide not to progress. Another conservation officer indicated that the reason they receive such a low number of SPDG applications is because in pre-application discussions they often dissuade applicants from using SPDG.

This data is not a good indication of where SPDG in listed buildings is becoming more prevalent because it is based on the perceptions of conservation officers (which are not always accurate) and does not reflect pre-application advice or whether applicants act on the consent having received it. Furthermore, the number of consent applications for SPDG will be influenced by the number of listed buildings in each local authority and to get an accurate depiction of where SPDG is becoming most common it would be necessary to search local authority databases for

listed building applications relating to SPDG and then compare this to the number of listed properties in that district.

Time constraints restricted this type of analysis, but data from City of Edinburgh council has been analysed. Edinburgh is an example of a local authority that has embraced SPDG in listed buildings, see section 3.7.1.3 on page 22. The figures set out in Table 8 show that where restrictions are relaxed, strong demand ensues from property owners to make traditional windows more energy efficient. SPDG is also facilitated in Edinburgh by the large number of small joinery companies who are prepared to repair traditional windows and retrofit thin double glazing into existing frames.

	1 October 2014 to 1 April 2015
Total number of applications to use SPDG in listed buildings	57
Applications granted	46
Applications refused	3
Applications pending decision	4
Applications withdrawn	4

Table 8: Listed building consent applications relating to SPDG in windows received by City of Edinburgh council from 1 October 2014 to 1 April 2015.

5.4 How conservation officers' approach to SPDG compares to guidance from the Heritage Agencies

Questions 10 to 14 were designed to meet the objective of comparing the attitude of conservation officers to SPDG to the guidance issued by Historic England, Historic Scotland and Cadw. Questions 28 and 29 were included to find out whether conservation officers refer to the guidance and how much they use it to inform their decisions. They were asked:

Q28. To indicate which guidance documents they are aware of.

Q29. How often they use the guidance to inform their decisions.

In response to Question 28:

- 94% of all conservation officers said they were aware of Historic England's paper – Traditional windows: their care, repair and upgrading (2014);
- 69% said they were aware of Historic Scotland's technical papers on the thermal performance of traditional windows and SPDG; and
- 88% said they were aware of SPAB's guidance document – Energy efficiency in old buildings.

These percentages remained very similar for England and Wales but Scottish respondents indicated that 78% of them are aware of the Historic England paper, 100% of them of the Historic Scotland papers and only 56% of them of the SPAB paper.

In response to Question 29, 62% of all respondents said they 'frequently' refer to guidance and 37% said they 'occasionally' refer to it. Conservation officers in England appear to refer to the guidance most often.

In their guidance, the Heritage Agencies advocate repair over replacement and are particularly resolute about the preservation of historic glass. Questions 10 and 11 tested how rigorously conservation officers' apply this guidance in practice by asking:

Q10. If they would consider allowing an SPDG unit to replace a traditional window which was not beyond repair.

Q11. If they would consider allowing SPDG units to replace a traditional window if it resulted in the loss of historic glass.

Figure 9 shows that 56% of conservation officers said they never allow SPDG to be used in listed buildings unless the original window is beyond repair; whilst Figure 10 shows that 61% said they would never allow it if it resulted in the loss of historic glass. Both of these results show that the majority of respondents adhere to guidance emanating from Historic England, Historic Scotland and Cadw about preserving traditional joinery and historic glass. A couple of the conservation officers explained their strict philosophy by commenting that it is more sustainable and cost effective to repair windows than to replace them with new SPDG units. 40% of the conservation officers, however, said that they occasionally allow SPDG units to replace a traditional window even if the window is not beyond repair; and 35% said they would occasionally sanction it, even if it led to the loss of historic glass.

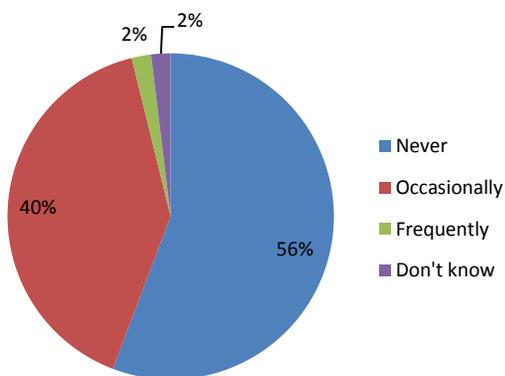


Figure 9: Total responses to Question 10

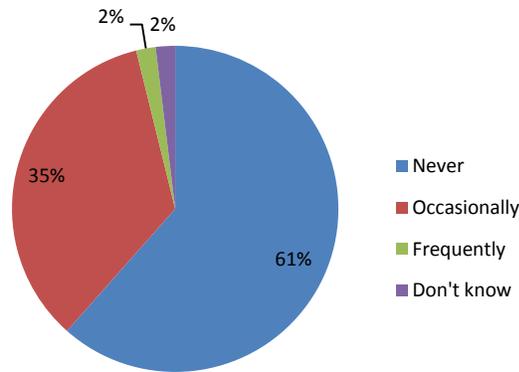


Figure 10: Total responses to Question 11

The comments on Question 10 add insight into the reasons why some conservation officers deviate from the guidance. Three conservation officers explained how they allow SPDG units to replace serviceable windows if it is part of a bigger renovation scheme that offers significant benefits for the whole building, for instance, where a listed building is ‘at risk’ due to it being unoccupied. Six conservation officers who answered ‘occasionally’ explained that their decision would depend on the significance and historic importance of the windows and their positioning. Another interesting comment was that although a conservation officer may recommend that a window should not be replaced, the development control team may decide otherwise.

The responses and further comments show that although many conservation officers are aware of the preference for repair over replacement, at times they find themselves having to adopt a more pragmatic approach. One of the reasons for this came to light through the interviews. Three of the seven conservation officers who were interviewed spoke of difficulties in finding joinery companies to carry out on-site repairs – the preference of joinery companies is to manufacture new windows in their workshops. One conservation officer from an English local authority said that “retention and repair is our gold standard but it is hard to find companies to carry out repairs. Over the past 5 years the number has declined significantly.” Another conservation officer from a local authority in a large English university town spoke of how the buoyancy of the city’s construction economy meant that it was hard to find a building firm to carry out small scale repairs.

The further comments made on Question 11 show how important respondents consider historic glass to be and reflect the significance that the Heritage Agencies attribute to. When conservation officers consent to applications that result in the loss of historic glass it is not without due consideration or justification. One conservation officer explained that if he refuses an application to replace windows on the basis of there being historic glass then this is often

followed up with “an ‘accident’ befalling the glass, usually involving a small child and a football.” Another conservation officer worries that refusing an application purely on the basis of loss of historic glass “would be problematic and unlikely to stand up at appeal.”

Some comments suggest that some development control teams and planning committees do not understand the significance or beauty of old glass and hence consent to applications that lead to its demise. The only conservation officer who indicated that he ‘frequently’ considers applications resulting in the loss of historic glass said that he often made consent conditional on the glass being carefully removed and stored for repairs on other windows. This is a compromise if the frame of the window is beyond repair.

	Q6, replacing a window not beyond repair. Response ‘never’	Q6, replacing a window not beyond repair. Response ‘occasionally’	Q7, loss of historic glass. Response ‘never’	Q7, loss of historic glass. Response ‘occasionally’
England*	66%	29%	66%	29%
Scotland	22%	78%	33%	67%
Wales	50%	50%	75%	25%

*Excludes one respondent who indicated ‘don’t know’ and one respondent who indicated ‘frequently’

Table 9: Responses to Questions 10 and 11 separated according to region.

The small sample sizes for Scotland and Wales make it difficult to draw firm conclusions from Table 9 but it is interesting that of the 9 respondents from Scottish local authorities, only 22% of them indicated that they would ‘never’ allow a window to be replaced with SPDG if it was not beyond repair, compared to 66% in England and 50% in Wales. Similarly, 33% of Scottish respondents said they would ‘never’ allow SPDG to replace historic glass compared to 66% of English respondents and 75% of Welsh respondents. These stark variations in approach between Scotland and the other regions could be interpreted as evidence of conservation officers in Scotland adopting a more liberal approach towards SPDG and one which has been advocated by Historic Scotland since 2007.

Questions 12, 13 and 14 were designed to further investigate how closely conservation officers follow the guidance from the Heritage Agencies. They were asked:

- Q12. Where the window to be replaced is a modern replacement, whether they would grant approval for SPDG units to be used.**
- Q13. Whether they are more likely to grant approval to replace a one-over-one sash window with SPDG than to replace a multi-paned sash window.**
- Q14. Where the window being replaced is multi-paned, whether they would allow the new window to consist of a single pane of SPDG with applied glazing bars or lead adhered to the glass.**

Both Historic Scotland and Historic England take a more relaxed approach to SPDG in listed buildings where it is replacing a modern rather than an original window and this is largely the case with conservation officers. The mean response to Question 12 was 2.11 which is closest to the code for the 'agree' option. 71% of respondents either agreed or strongly agreed with the statement in Question 12. The main reasons given for agreement were that it is either an opportunity to achieve aesthetic enhancement if the existing modern window is out of character e.g. upvc or a modern casement window within a Georgian façade; or because the argument against SPDG is weakened if there is no loss of historic glass or traditional joinery.

A conservation officer from a Scottish local authority made the following comment, "If the windows are a good replication of the original design then we would encourage the insertion of SPDG into the current frames. If the replication is poor then we would look for an improvement in form." Two other conservation officers – one from Wales and the other from Scotland – made the point that SPDG provides a good opportunity to reverse harmful alterations of the past and that it can act as a catalyst to achieve uniformity in a group of buildings whilst improving energy efficiency. An example of this is in the Housing Renewal Schemes in Welsh conservation areas.

It is significant though, that nine respondents disagreed with the statement in Question 12 and they were all from local authorities in England. The reason mentioned by a number of them was that if the adjacent windows are single glazed then SPDG may still be inappropriate because the flat reflection from SPDG is noticeable when located close to single glazing.

Questions 13 and 14 are important for testing the extent to which conservation officers follow guidance from Historic England and Historic Scotland. Research from Glasgow Caledonian University showed that SPDG performs better when fitted into Victorian 'one over one' –paned sash windows than into multi-paned Georgian sash windows; and that it can achieve U-values that are greater than those achieved from secondary glazing (Baker and Heath, 2010). For this reason and because it is easier to replicate the joinery details of an original window if there are no glazing bars, Historic England are more supportive of SPDG in Victorian style windows than in Georgian style windows.

Of the 49 respondents who answered Question 13, 18% of them strongly agreed and 53% agreed – suggesting that the majority of them follow the guidance closely. However, 29% disagreed and the explanation that some of them gave was that it is now 'entirely possible' for new multi-paned windows containing SPDG to be made that replicate original windows so why should it make a difference? This indicates that many conservation officers, understandably, are concerned about aesthetics rather than energy efficiency and that joinery techniques are constantly developing to accommodate double glazing into as fine a glazing bar as possible. One conservation officer made the point that he is more likely to receive an application to

replace a 'one over one' –paned window with SPDG than a multi-paned one because it is “cheaper and easier to achieve an accurate duplicate incorporating SPDG”.

Question 14 refers to the situation where a window consists of a single pane of SPDG with timber glazing bars or lead applied to the outside and inside faces of the glass or sometimes sandwiched in between the glass. Windows constructed in this way are often half the price of traditionally constructed windows and have a greatly improved U-value. This type of construction for listed buildings is currently strongly opposed by the Heritage Agencies, despite representation from the glazing industry.

Statistical analysis shows that the mean response for Question 14 was 1.23 which is closest to the category where respondents said they would 'never' consent to applied glazing bars or lead. The low standard deviation of 0.43 shows that there is a narrow spread of responses indicating high consensus on this issue. Figure 11 below shows that 75% of respondents said that they would 'never' consent to applied glazing bars. 23% (12 people in total) indicated that they would 'occasionally' consider it, particularly if the replacement window was a marked improvement on a poor quality, existing window. SPDG units with applied glazing bars are cheaper and more energy efficient than those with integrated bars and they enable very narrow glazing bar detail but they do not accurately represent traditional joinery, do not produce the multi-faceted reflectivity of individual panes of glass and can suffer from the glazing bar adhesive failing.

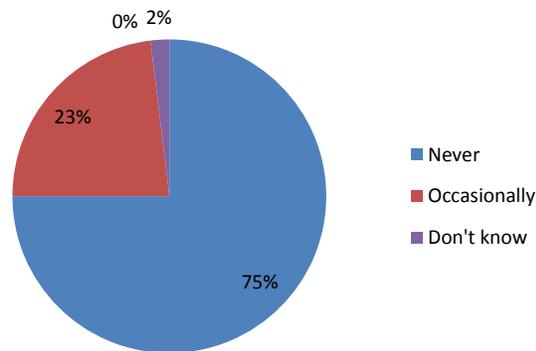


Figure 11: Total responses to Question 14

5.5 Retrofitting SPDG into existing window frames

This is an issue where the advice from Historic Scotland and Historic England has been quite different and Questions 18 to 20 were designed to investigate whether their different guidance has encouraged different practices between Scotland and the rest of the UK. Historic Scotland has always been more encouraging than Historic England about the incorporation of SPDG glass into original windows. Even back in 2010 they were advising that, “Recent research has

demonstrated that slim profile double glazing can be successfully accommodated into historic window frames,” (2010c). At the same time Historic England were showing considerable reticence towards this procedure. Conservation officers were asked:

Q18. How often they receive applications to fit SPDG glass into existing window frames.

Figure 12 shows that 71% of respondents occasionally receive applications to retrofit glass, compared to 17% indicating ‘never’ and 4% indicating ‘frequently’. If the results are analysed according to region then it shows Scotland having the lowest number of respondents saying they ‘never’ receive applications to retrofit glass and Wales having the highest number but the small sample sizes make it difficult to use this data to draw firm conclusions. However, some of the comments made within the survey and during interviews indicate that the retrofitting of glass is a more common procedure in Scotland than elsewhere.

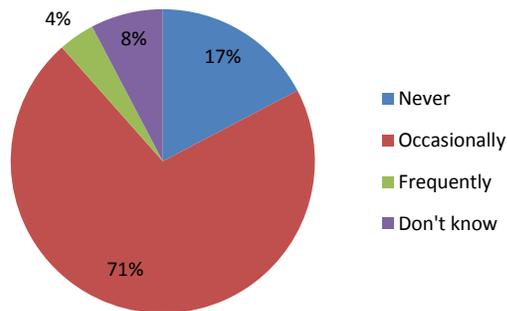


Figure 12: Total responses to Question 18

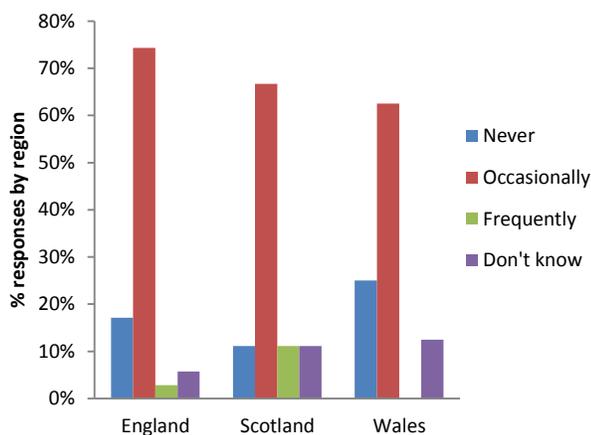


Figure 13: Responses to Question 18 according to region

One conservation officer from Scotland commented in the survey that retrofitting is “the method of replacement that we try to encourage” whilst another said that she had seen many examples of where it has worked well. In contrast, one conservation officer from England wrote that potential applications are often ruled out because of the alterations involved in accommodating the extra weight of glass; and another wrote that in her experience it is difficult to achieve and often done poorly.

From the interviews, one conservation officer from Wales and another from England explained that their biggest problem with fitting SPDG glass into original windows is finding companies to do it. In Scotland there are specialist joinery firms skilled in repairing and re-glazing original windows with SPDG. Another conservation officer from a local authority in the South East said that she’d noticed that applications for the retrofitting of SPDG were increasing but that, in the case of listed buildings, their team continued to refuse them. She feels that they are on “shaky ground” and would like to see the issue tested through the appeal system to help them decide on their policy going forward.

One conservation officer interviewed from a Scottish local authority mentioned that the Conservation Area Regeneration Scheme (CARs) gives financial support for the retrofitting of SPDG in traditional buildings. A pilot scheme to provide grants for energy improvements run by Haringey council, on behalf of six London boroughs, part-finances the fitting of SPDG into existing windows but knows of only one company that does it and therefore finds it impossible to get competitive quotes.

Further evidence of the retrofitting of SPDG being a more common procedure in Scotland comes from looking at listed building consent applications to City of Edinburgh council from 1 October 2014 to 1 April 2015. Of the 57 applications to use SPDG in listed buildings, approximately 20 of them were for SPDG glass to be fitted into the original window frames. Although this method of accommodating double glazing into listed buildings appears to be less common outside of Scotland there are two high profile examples of it in England and Wales.

In 2014, after opposition from Historic England and the Georgian Society, Cambridge City Council granted permission for Trinity College (a Grade I listed building) to replace the single glazing in its windows with conservation slim profile double glazing manufactured by Histoglass. This was part of a £10 billion pound project to reduce the College’s carbon emissions by 80-88% (Lonsdale, 2013).

In 2013, Cadw granted consent for the fitting of SPDG to sixteen metal crittal windows in Swansea’s Guildhall (a Grade I listed building). The secondary glazing was causing condensation which was damaging the internal wall fabric so it was decided to remove it and replace the single glazing with 20mm double glazing to approve the acoustic and thermal qualities of the rooms (Powell Dobson, 2013).

Questions 19 and 20 asked the following:

Q19. If there is no historic glass present, whether they would be more likely to approve the fitting of SPDG glass into an existing window frame than approve an entirely new SPDG unit.

Q20. Whether they consider the replacement of glass in a traditional window with SPDG glass to be a viable option.

Figure 14 shows an overwhelming majority of Scottish respondents (78%) answering ‘yes’ to Question 19. This compares to 37% of English respondents and 25% of Welsh respondents. Although no respondents from Scotland and Wales answered ‘no’, there were nine respondents from England who answered ‘no’ with the following comments being given:

- “The rebate required is usually too damaging.”
- “The principle is about the use of double glazing, the age of the glass is not a factor.”
- “This is difficult to achieve in practice. Historic fabric is more than just the glass and traditional sliding sashes with pullies will need to be taken apart and will more than likely result in wholesale replacement to achieve the appropriate balances.”

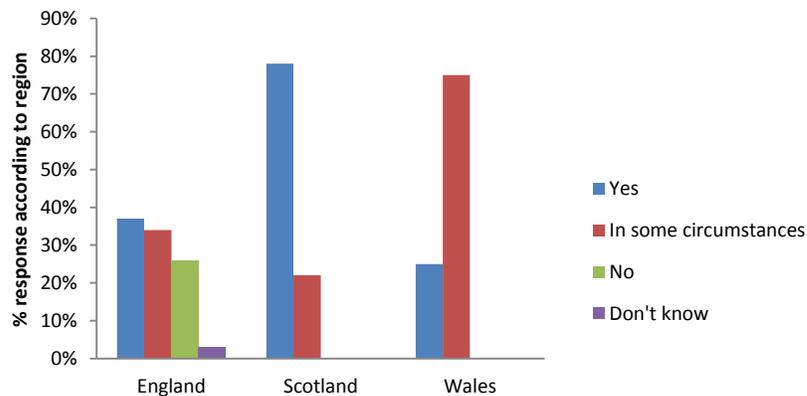


Figure 14: Responses to Question 19 according to region

Question 20 appears to have generated some confusion and resulted in a number of ‘don’t knows’ and no responses. The comments identify some concern amongst conservation officers about the lifespan of SPDG glass and scepticism about how much it can improve the thermal performance of a listed building. One conservation officer from England commented that he receives far fewer applications for the retrofitting of glass than are actually viable but this is because “most joiners appear to vastly prefer constructing new windows.”

5.6 Energy efficiency and conservation

Questions 21 and 23 were included to test the conflict between improving the energy efficiency of listed buildings and preserving their historic integrity. Conservation officers were asked:

- Q21. If a traditional window needed to be replaced how likely would they be to stipulate that single glazing be used.**
- Q23. Where appropriate, could they see themselves advising listed property owners applying to replace windows, to use SPDG over single glazing.**

Single glazing is normally stipulated in a replacement window where the character/uniformity of the building would be compromised by the use of SPDG or where the glazing bars are so thin that no new window containing SPDG would be a close enough facsimile of the original. However, the stipulation of single glazing clearly has its disadvantages in terms of thermal performance and it is this conflict that is becoming increasingly played out between property owner and conservation officer. For the whole sample, 54% of the respondents indicated 'frequently' in response to Question 21, 35% indicated occasionally and 12% answered 'don't know' (mainly commenting that each application needs to be assessed on its own merits). If the responses are separated according to region the following is revealed:

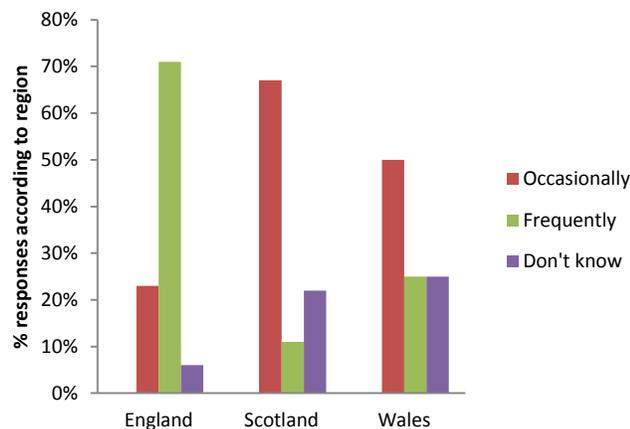


Figure 15: % responses to Question 21 according to region

Figure 15 shows that out of the 35 conservation officers from local authorities in England, 71% said they would frequently stipulate single glazing whereas out of the 9 conservation officers from Scotland only 1 of them indicated frequently and for Wales only 2 of them indicated frequently. Despite the small sample sizes, this data does seem to imply that in England conservation teams are extremely focused on maintaining historic integrity and are not prepared to compromise it for the sake of energy efficiency. In Scotland, and to a lesser extent in Wales, this conflict does not appear to be so apparent.

Question 23 was included to test whether conservation officers feel they have any responsibility towards making listed property owners aware of SPDG as an energy efficient alternative to single glazing. Figure 16 shows the responses of the whole sample.

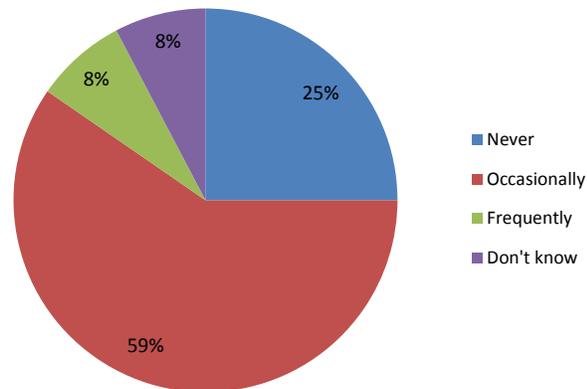


Figure 16: Total responses to Question 23

Analysis of the responses from England, Scotland and Wales show very little variation apart from a higher percentage of Welsh conservation officers saying that they would ‘occasionally’ offer advice about SPDG compared to those in England and Scotland. On this question, however, it is the comments that are most revealing. Eleven respondents said they would advise owners about SPDG if the window under discussion was of inappropriate, modern design and there was to be, “A net gain in terms of appearance/character.” Two respondents said that they would be very wary of advising about SPDG because of the risk of the units failing. Another two said they felt it was outside of their remit to encourage SPDG with one commenting:

“It is outside of my brief to promote the use of double glazing and in fact it would never need to happen as our applicants would be very likely to be looking for double glazing.”

The following comment was made by a Scottish conservation officer and reinforces their endorsement of the retrofitting SPDG into existing windows – “It is up to the applicant to provide justification as to why they need to have double glazing. If this case is made then I would recommend slim line double glazing as a viable solution over the wholesale replacement of the window itself.” Another Scottish conservation officer made the point that she may advise SPDG, “depending on the whole package of change and whether it would help preserve the listed building.”

5.7 Identifying problems with SPDG

Question 34 asked conservation officers to:

Q34 Identify which issues they consider to be a concern in relation to SPDG in listing buildings.

The options they were given to choose from were: reflection from the glass, colour/look of spacers, thickness of glazing bars, lifespan of the units, visibility of the edge seals and nature of the bedding material. There was also a box where they could indicate additional concerns not covered by the other options. Respondents were asked to rank their concerns from 1 (greatest concern) through to 7 (least concern). There was an option to tick an n/a box if an issue was of no concern which was coded as 8 for the purposes of analysis.

Table 10 shows that the issue of greatest concern by a considerable margin was the thickness of glazing bars required to support SPDG. This concern achieved an average score of 1.89, indicating that most people ranked it as either their first or second choice. The low standard deviation shows that there was considerable consensus amongst respondents. Glass reflection achieved an average score of 3.09 but with a relatively high standard deviation indicating that although on average most people ranked it as their 3rd choice there was a wide spread within the data with 2 respondents ranking it of no concern at all.

The colour/look of the spacer bars between the panes of glass was the third greatest concern and the lower standard deviation indicates that there was more consensus amongst respondents on this issue than for glass reflection. The concern over lifespan of the SPDG units is interesting because it has the second highest standard deviation which indicates that for some respondents it was one of their highest concerns (9 people ranked it 1st or 2nd) whilst for others it was of very little concern (18 people ranked it 6th, 7th or n/a). In the cases where the option 'other' was attributed a high rank the comments explained that it was the loss of historic fabric that troubled them most about SPDG or because they felt the money spent on SPDG could be better spent achieving more effective energy efficiency improvements.

	Thickness of glazing bars	Glass reflection	Colour/look of spacers	Visibility of edge seals	Lifespan	Bedding material	Other
Minimum rank	1	1	1	1	1	1	1
Maximum rank	5	8	8	8	8	8	8
Mean	1.89	3.09	3.30	4.26	4.47	4.81	6.55
Standard deviation	1.20	1.93	1.43	1.33	1.85	1.51	1.7
Total responses	47	47	47	47	47	47	47

Table 10: Statistical analysis of Question 34

Data from the interviews reveals a bit more about why conservation officers see glazing bars as their greatest concern. Although new joinery techniques and reduction in the depth of the edge seals of SPDG mean that it is possible to accommodate SPDG into narrow glazing bars, it is

an expensive procedure and many people are not prepared to pay for bespoke craftsmanship. Instead, they go to large scale manufacturers who do not replicate the existing window detail and produce glazing bars which are too wide and flat. This may be a significant problem in Scotland because if the responses from Question 34 are separated according to region the average score for glazing bars from conservation officers in Scotland is considerably lower than that for the whole of the UK (1.22 versus 1.89). There is also a very low standard deviation of 0.44 indicating that all Scottish respondents ranked glazing bars as either their first or second greatest concern. Welsh conservation officers on average ranked glass reflection as their greatest concern but this is a very small data sample with a high standard deviation.

One respondent from England made the following comment about glass reflection:

“I wish to clarify my view on 'reflections' - how anyone can advocate secondary glazing and then criticize double glazing on the basis of 'reflections' is utterly beyond me. [Glazing bars, spacers and edge seals] can have major disfiguring effects on the appearance of a window but provided you are aware of this and specify, or condition appropriately, such results are relatively easy to avoid.”

Respondents were also given the opportunity to respond in their own words about their concerns over SPDG and about changes they would like to see made. Questions 33 and 35 asked:

Q33. Whether they have concerns about the use of SPDG in listed buildings.

1. Whether there are any changes that they would like to see in SPDG units that would make them more compatible for use in listed buildings.

In response to Question 33, 81% said they had concerns and only 10% said they had no concerns. Of the fourteen individuals who chose to comment further, the most widespread concern (mentioned by six respondents) was the longevity of the units and a concern that they often fail. Three respondents mentioned that the colour of the spacer bars is a problem, with black being the most obtrusive; a further two articulated that their concern is over SPDG being seen as a “panacea” for energy conservation in old buildings which is rarely the case; and another one mentioned the visible trademarks that appear on some SPDG glass.

Only nine people commented on Question 35 and of these, three of them felt that the change they would most like to see is the incorporation of less perfect glass in the outer pane of SPDG to counteract the problem of the flat reflection. However, despite many SPDG manufacturers offering conservation glass with purpose made ‘imperfections’ it is not something that conservation officers often specify in their conditions of consent. In response to Question 27 which asked if they have ever specified that the external pane of glass in an SPDG unit be made using ‘handmade’ glass, 63% of the total sample said they had ‘never’ done this and 33% said

they had specified it 'in some circumstances.' One respondent from Wales commented that she had never specified it but that "it might make the use of SPDG more desirable."

Other comments indicate that there is a certain amount of scepticism about historic effect or conservation glass with one respondent saying that the glazing samples he had seen were "a very poor effort"; another saying that she felt that "we shouldn't insist on handmade glass to give the impression that it is old;" and another queried whether it can "cope with the vacuum pressure?" Responses to Question 27 show that, where glazing manufacturers make positive developments to refine the look of SPDG, they must make efforts to communicate these improvements to the conservation world.

5.8 Variations in approach between different local authorities

One of the objectives of this research was to investigate whether there is a variation in the approach to SPDG between conservation officers which leads to accusations of it being a "postcode lottery with decisions varying from area to area," as to whether applications are granted or refused consent (Listed Heritage, 2014).

Very few listed buildings are identical and the windows within them are diverse and make different aesthetic contributions to the buildings they form part of. This means that to the untrained eye, windows in one building might appear similar to windows in another when, in conservation terms, they are different due to glazing bars, historic glass, their impact on the character of the building, elevation, group value etc. This has always, quite rightly, been the defence of conservation officers when they have been accused of inconsistency in their decisions. However, there is evidence from the survey responses, local authority databases and interviews that, despite areas of commonality between windows, there are stark differences in approach between different conservation officers. In some cases this results in SPDG applications that may have been granted consent in one local authority being refused in another.

The case studies in Table 11 were taken from the planning databases of different local authorities and demonstrate how different the decisions made over SPDG can be.

	Listed building consent granted	Listed building consent refused
Location number	1	2
Local Authority	Vale of White Horse	Bath & North East Somerset
Date	December 2013	March 2015
Listing	Grade II	Grade II
Age/style of building	18 th century thatched cottage	17 th century farmhouse with 19 th and 20 th century additions
Window type	Timber casement windows, single glazed	19 th century timber casement windows, single glazed
Details of application	Retrospective consent sought to replace all the windows with traditional style timber casements containing SPDG.	Retrospective consent sought to replace timber casements with traditional-style casements containing 12mm SPDG.
Decision	Consent granted.	Consent refused due to inadequate justification and because double glazing is considered harmful to an historic building.
Location number	3	4
Local Authority	Edinburgh City Council	Westminster Borough Council
Date	January 2015	January 2015
Listing	Category A	Grade II
Age/style of building	Georgian terraced house	Georgian town house
Window type	Victorian 'one over one' timber sliding sash windows, single glazed	Victorian 'one over one' timber sliding sash windows, single glazed
Details of application	All windows on the front elevation to be renovated and fitted with SPDG glass	Consent sought to replace 3 windows on the front elevation with replica timber windows containing SPDG
Decision	Consent granted.	Consent refused because double glazed units are not appropriate in a Georgian building.

	Listed building consent granted	Listed building consent refused
Location number	5	6
Local Authority	Rushcliffe Borough Council	Basingstoke and Deane
Date	November 2014	October 2013
Listing	Grade II	Grade II
Age/style of building	17 th century farmhouse with 18 th and 20 th century additions	A pair of 19 th century estate cottages
Window type	Timber sash windows, single glazed	Timber casement windows, single glazed
Details of application	Consent sought to replace all the windows on the front elevation with new replica windows containing SPDG.	Consent previously granted for new single-glazed windows to be fitted. Additional consent sought for SPDG to be used instead of single glazing.
Decision	Consent granted.	Consent refused due to the adjacent cottage having single glazing and the unsightly double register from SPDG.
Location number	7	8
Local Authority	Cotswolds	Cotswolds
Date	May 2014	August 2011
Listing	Grade II	Grade II
Age/style of building	Late 18 th century inn facing the village green	Mid 19 th century commercial premises within row of similar buildings
Window type	Late 19 th century timber casements, single glazed	Mid 19 th century timber casements, single glazed
Details of application	Consent sought to replace all windows on the front elevation with replica timber windows containing SPDG	Consent sought to repair the rotten timber windows and replace the single glazing with 14mm SPDG
Decision	Consent granted	Consent refused due to the flat reflection of SPDG and potential visibility of the spacer bar.

	Listed building consent granted	Listed building consent refused
Location number	9	10
Local Authority	Vale of White Horse	Cotswolds
Date	September 2014	April 2013
Listing	Grade II	Grade II
Age/style of building	Mid 18 th century Georgian house facing the street	Late 18 th terraced house facing the street
Window type	20 th century side hung timber casements	'Six over six' –paned timber sliding sash windows
Details of application	Consent sought for all windows on the front elevation to be replaced with timber casements with a different pane configuration containing SPDG.	Consent sought for two windows on the front elevation to be replaced with similar timber sashes containing SPDG
Decision	Consent granted	Consent refused because replacement of the original windows with fine glazing bars had not been convincingly justified.

Table 11: Examples of listed building consent applications for SPDG from different local authorities

Some local authorities take a very strict line on SPDG in pre-twentieth century listed buildings and refuse all applications relating to it. Many of the London boroughs appear to take this approach as does Bath and North East Somerset. For example, in location 4, Westminster Borough Council refused an application to replace three Victorian 'one over one' –pane sliding sash windows on the front of a Grade II Georgian town house with replica timber windows containing SPDG. The reason given was that double glazed windows are not appropriate in a Georgian building. At the same time, in location 3, Edinburgh City Council granted consent for SPDG glass to be retrofitted into the existing, front elevation sash windows of a Category A Georgian terraced house.

Similarly, in location 2, Bath & North Somerset council refused retrospective consent to replace nineteenth century timber casement windows in a Grade II listed farmhouse with replica SPDG casements and argued that double glazing is considered harmful to an historic building. In contrast, a year earlier, in location 1, the Vale of White Horse council granted retrospective consent to replace all the casement windows in a Grade II listed thatched cottage with SPDG.

Some local authorities do not refuse SPDG applications as a matter of principal but require convincing justification as to why it is necessary. Many applicants fail to argue their case sufficiently. For example, in location 10, Cotswold district council refused an application to replace two multi-paned sash windows on the front of an eighteenth century terraced house facing the street because the loss of the original windows had not been 'convincingly justified'. In contrast, Vale of White Horse agreed to new windows containing SPDG to replace all the

windows on the front of an eighteenth century house facing the street and they also permitted the pane configuration of the new windows to be different from the originals.

Other local authorities seem to refuse SPDG applications because they are not happy with the end product, very commonly because of the flat, clear reflections that emanate from the glass. For example, in location 6, Basingstoke and Deane council agreed to single glazed replacement windows on a nineteenth century estate cottage but when a further application was submitted to change the glass to SPDG they refused on the grounds that the adjacent cottage had single glazing and there would be an unsightly double register from the double glazed glass. A year later, Rushcliffe Borough council had no such reservations and granted consent at location 5, a seventeenth century farmhouse, for all the windows on the front elevation to be replaced with new windows containing SPDG.

The following quotes taken from the survey demonstrate the full spectrum of views about SPDG held by conservation officers:

- SPDG units, “by definition will always be an intrusive and inappropriate modern alteration.”
- “We consider SPDG unacceptable, in principle, in 18th and 19th century buildings but we do allow it in some 20th century commercial buildings.”
- SPDG is “one factor that can assist in providing improvements in thermal performance but I consider that other simpler/less intrusive improvements are often overlooked due to the over-publicity that is given to windows.”
- “We take each building on a case by case basis and will allow SPDG where possible.”
- Approving the use of SPDG “would depend on the whole package of change and how it would help preserve the listed building.”
- “Blanket negativity to SPDG and an inability to carefully think ‘where is the demonstrable harm’ caused to the listed building may result in unnecessary appeals.”
- “I do worry that unless a more open-minded approach to energy efficiency in historic and listed buildings is taken then in a world where these issues are considered of great importance there may be a loss of faith in the conservation of historic buildings in principle. Ultimately if the conservation professionals and existing systems cannot be demonstrated to be taking reasonable steps to balance preservation with energy efficiency then such issues might be taken out of our hands in the future.”

Inevitably these different viewpoints result in different decisions being made about SPDG in listed buildings not just between England, Scotland and Wales but also between local authorities in closer proximity to each other and, in a few cases, between individuals within the same local authority.

It is worth pointing out that most conservation officers’ act as advisers to the development control teams, rather than case officers, and although they give their advice it is not always

accepted. Furthermore, as one respondent noted, “The assumption is that all such decisions are made by the conservation officers, when in many local authorities listed building consent applications are picked up by other planning staff, not always with specialist conservation background.” Similar comments to this were made throughout the survey and are evidence that inconsistency in decision making arises not just because of differences of opinion towards SPDG amongst conservation officers but also because development control teams sometimes make the final decisions.

6 Discussion

The objectives of this project are:

- to research the attitudes of conservation officers in the UK to the use of SPDG in listed buildings;
- to assess whether and how the approach to SPDG in listed buildings varies between different local authorities; and
- to compare the approaches of conservation officers to SPDG in listed buildings to guidance issued by Historic England, Historic Scotland and Cadw.

Having collected and analysed the quantitative and qualitative data, the following observations and conclusions can be made about the research.

6.1 Data collection

As with all data collection there are deficiencies which revealed themselves over the course of the research.

The questionnaire asked too many questions which created more data than it was possible to analyse within the time frame. A smaller number of questions may have reduced the number of incomplete surveys and improved the response rate. With hindsight, the questions that could have been excluded were those that focused on the positioning of windows (Questions 15, 16 and 17); and those relating to the technical specifications of SPDG (Questions 24, 25 and 26).

Many of the survey questions had a ‘don’t know’ option which in most cases was used, as expected, to indicate that a respondent was unable to answer the question. In some cases, however, it was used to indicate that the respondent was neither in agreement nor disagreement with the statement. In questions where many conservation officers used the ‘don’t know’ box to reflect their uncertainty about an issue, as with Question 6, it became difficult to know whether to include or exclude the answers for the purposes of analysis because they were revealing ambivalence which was important. In retrospect it would have been better to have a five point likert scale with a ‘neither agree nor disagree’ option as well as a ‘don’t know’ option.

Low numbers of conservation officers responding from Scotland and Wales made it harder to draw conclusions about differing approaches between England, Scotland and Wales. Although efforts were made to increase the number of survey responses from conservation officers operating in Scotland and Wales, the number of participants from these regions remained low.

Surveys and interviews obviously suffer from participation bias because the people who take the time to complete them tend to be interested and well informed on the topic. More time to conduct database searches on local authority websites where there are no conservation officers or where the conservation officer is less informed about SPDG may give a clearer picture of the trends in SPDG and decisions made relating to it across the whole country.

6.2 Attitudes of conservation officers across the UK to SPDG in listed buildings

The approach of conservation officers towards SPDG can be broadly separated into the following categories although these are generalisations and some conservation officers fall outside of or between these categories:

1. Those who adopt a blanket opposition to SPDG in listed buildings built prior to 1900 on the basis of it being inauthentic and inappropriate. Some of the conservation officers in London fall into this category. Conservation officers in this category do not allow SPDG in modern replacement windows and are unlikely to allow it in new extensions to listed buildings. Most conservation officers in this category understand the importance of energy efficiency but they do not think it should be prioritised at the expense of historic fabric. They advocate non-intrusive measures such as shutters and heavy curtains to improve the thermal performance of windows and would never consider advising applicants about the possibility of SPDG. The flat, uniform reflection from SPDG is considered a major problem. A small minority of conservation officers in this category express the view that energy efficiency should not be considered important in this section of the country's building stock. For instance, one conservation officer wrote in response to Question 5 which asked whether they thought energy efficiency was important in listed buildings, "Does the question mean I think listed buildings should be energy efficient (I strongly disagree) or that the people trying to upgrade listed buildings is a massive problem (I strongly agree)." Roughly 25% of the surveyed conservation officers fall into this category and most of them are based in local authorities in England.
2. Those who are prepared to consider SPDG in listed buildings in limited circumstances, particularly where there is no loss of historic fabric. Examples would be in modern extensions; where an inappropriate modern window is being replaced; at the rear of listed buildings which have undergone alteration; and where the traditional window is beyond repair and is not adjacent to single glazed windows. They commonly stipulate that single

glazing be used in new replacement windows, for instance 54% of respondents answered 'frequently' in response to Question 21 which asked them to indicate how often they insist on single glazing (see section 5.6). Conservation officers who fall into this category tend to be less concerned about glass reflection and more concerned about ensuring the glazing bar detail is correct. They are more likely to agree to SPDG in a 'one over one' –paned window than a multi-paned window because it is easier to replicate the joinery detail (see responses to Question 13 in section 5.4) but they would never agree to SPDG units with glazing bars applied to the glass. For instance, in section 5.4 above, Figure 11 shows that 75% of respondents indicated 'never' in response to Question 14 which asked them about applied glazing bars. Conservation officers in this category would be more likely to approve the fitting of SPDG glass into existing frames if it could be achieved successfully. Roughly 55% of surveyed conservation officers fall into this category.

3. Those who are broadly supportive of SPDG providing it does not result in the unnecessary loss of traditional joinery or historic glass. Some of the conservation officers in Scotland would fall into this category as well as a few in England and Wales. They tend to favour SPDG in 'one over one' –paned windows because of its better thermal performance. In appropriate circumstances, they would consider advising property owners about SPDG, for instance, in response to Question 23 one conservation officer made the following comment, "I would inform the owner that the option exists and it might be acceptable in this case but I would not press the issue or try to sell them SPDG as being a valuable and beneficial investment." They recognise the benefits of SPDG in terms of improved thermal performance and comfort levels and would permit it (despite loss of historic fabric) if it improved the long term viability of a listed building. They 'occasionally' stipulate single glazing (see responses to Question 21 in section 5.6 above) because "context is important, especially if the replacement window is the only new window in a facade that otherwise retains all its original windows". They show concern over the lifespan of SPDG and that it is mistakenly seen as a panacea to improving thermal performance (see section 5.7). A few of them may consider stuck-on glazing bars, in the case of leaded lights; where it enables the glazing bars to be of very narrow dimension; or if it means that an inappropriate window is replaced by something better (see responses to Question 13 in section 5.4). Roughly 20% of conservation officers fall into this category.

6.3 Similarities and differences in approach between local authorities

6.3.1 Regional variations

The small sample sizes for Scotland and Wales make it difficult to draw firm conclusions but there is some evidence that, on average, there is greater acceptance of SPDG amongst conservation officers operating in Scotland than amongst those operating in England, and to a lesser degree, Wales. For example, the analysis of responses to Questions 10 and 11 in section

5.4 show that of all three regions, Scotland has the lowest percentage of conservation officers saying that they would 'never' agree to the use of SPDG in windows that were not beyond repair or where historic glass was present. This is not to say that none of the Scottish conservation officers have concerns about SPDG nor that no English or Welsh conservation officers are supportive of its use but there does seem to be more willingness in Scotland to try to accommodate SPDG where possible.

Conservation officers in Wales and England appear to adopt a similar approach to SPDG although on some issues Welsh conservation officers have a more liberal stance. For instance, the results from Question 19 in section 5.5 show that they are more open to the idea of retrofitting SPDG into existing windows than their English counterparts and the responses to Question 21 in section 5.6 show that a significantly lower percentage of Welsh respondents 'frequently' stipulate single glazing in replacement windows compared to English respondents.

One area of clear distinction between Scotland and the rest of the UK is in the retrofitting of slim profile double glazed glass into the rebates of existing traditional windows (see results from Question 19 in section 5.5). This is a procedure that has been supported by Historic Scotland since 2010 and conservation officers in Scotland show overwhelming support for its use. Some local authorities in England are receiving more applications for SPDG retrofitting but many are wary of it because they have not seen it done well and, up until now, it has been something that Historic England has not endorsed. There are many more companies in Scotland prepared to repair and retrofit traditional windows than in the rest of the UK and the lack of joinery companies prepared to do this type of work was identified by English conservation officers as being a problem (see quotations from English respondents in section 5.5). On average, conservation officers in Wales show greater enthusiasm for the retrofitting of SPDG than their counterparts in England (see Figure 14 , section 5.5).

The evidence suggests that a lot of conservation officers in English local authorities are extremely focused on preserving the historic integrity of the listed buildings in their area. As a result they are more likely to stipulate the use of single glazing than conservation officers in either Scotland or Wales and this has obvious implications for energy efficiency (see Figure 15, section 5.6). A few conservation officers in England believe that there is a need to support changes which improve energy efficiency to prevent listed buildings becoming expensive luxuries and encouraging development control teams to ignore their advice. Conservation officers in England were more likely to disagree that SPDG is a good way of improving the energy efficiency of listed buildings than conservation officers in either Scotland or Wales. For instance, Figure 7 in section 5.2 shows that 45% of English respondents either disagreed or strongly disagreed that SPDG is an important factor in improving the thermal performance of listed buildings compared to 22% of Scottish respondents and 25% of Welsh respondents.

There was consensus, on average, between conservation officers in Scotland and England that the thickness of glazing bars is their primary concern associated with SPDG in listed buildings. Conservation officers in Wales, on average, indicated that glass reflection was their most important concern. Across the UK, glass reflection is considered a concern by conservation officers where SPDG is in close proximity to single glazed windows (see results from Question 34 in section 5.7).

6.3.2 Local variations

The conservation officers who responded to the survey showed that they are well briefed and relatively up-to-date in their knowledge of SPDG. A majority of them adopt a cautiously positive approach and are prepared to accommodate SPDG providing the impact on historic fabric is minimized. The guidance issued by Historic England, Historic Scotland and Cadw is the means by which conservation officers make sure they are following the right path. The appeal system is the benchmark measuring whether the guidance is being correctly interpreted and applied to real life situations. If too many cases get taken to appeal or the Planning Inspectorate starts to overturn decisions made in relation to SPDG then this is the cue for conservation officers to adapt their approach. Once appeal decisions have been made they get circulated to conservation officers by Historic England.

Conservation officers within the same local authority tend to adopt the same approach to SPDG because to do otherwise would lead to unnecessary appeals and confusion. 85% of the respondents either agreed or strongly agreed that, "Their team makes consistent decisions relating to SPDG." The further comments in response to Question 31 indicate that the main reasons for inconsistent decisions within a local authority are where development control teams make decisions without specialist input; where there are periods of high staff turnover; and where conservation officers find it hard to keep up with technological developments in the SPDG industry.

There is sufficient evidence to support the view that within certain parameters, whether an application for SPDG gets granted or refused, depends on where the listed building is located (see Table 11 in section 5.8). The results from the survey, database research and interviews indicate that the full spectrum of approaches to SPDG are held: from conservation officers who strongly oppose it on grounds of inauthenticity; to those who mildly oppose it for its potential incursion on historic fabric; to those who tentatively support it in selective circumstances; and to those who actively support it as a comparatively benign means of improving thermal performance. For instance, the quotations taken from the survey and included in section 5.8 are evidence of these distinctively different approaches.

Conservation officers have sufficient influence within the planning departments to control the outcome of most listed building consent applications and therefore are responsible for the way that SPDG is assimilated into listed buildings across the UK. There are lots of cases where SPDG

is clearly inappropriate in historic buildings, but the case studies in Table 11 show that there are situations where two similar applications achieve different planning outcomes due to conservation officers' support or opposition to SPDG.

6.4 Comparison of the approach of conservation officers to the guidance issued by the Heritage Agencies

Section 3.7 gives a detailed synopsis of the guidance issued by Historic England, Historic Scotland and Cadw on the application of SPDG in listed buildings.

- Cadw has tended not to issue its own guidance but to rely on publications by Historic England and Historic Scotland.
- Historic Scotland have been proactive in commissioning research into the in-situ thermal performance of SPDG on which to base their advice. Their guidance has been supportive of SPDG as part of a drive to improve energy efficiency providing it does not destroy the special character of a listed building nor lead to the loss of historic glass. They have always supported the retrofitting of SPDG glass as a means of preserving original joinery.
- Historic England, up until recently, have shown reticence towards SPDG in listed buildings and have given little encouragement towards the retrofitting of SPDG glass. Their guidance paper in 2014 is more conciliatory with cautious support given to the retrofitting of glass and the replacement of irreparable or inappropriate windows with SPDG units.

In general, most of the surveyed conservation officers follow the guidance fairly rigidly.

Historic Scotland's pro-active stance towards improving the energy efficiency of listed buildings has fed through to conservation officers in Scotland with 100% of them either agreeing or strongly agreeing that energy efficiency in listed buildings is important (see Figure 5 in section 5.2). The practical research projects that Historic Scotland commissioned led them to confidently support SPDG in the right circumstances and this positive yet considered stance is apparent in the responses of Scottish conservation officers. A higher percentage of Scottish conservation officers agreed that SPDG was an important factor in improving the thermal performance of listed buildings than in England (see Figure 7, section 5.2). Historic Scotland took an early decision to encourage the fitting of SPDG into the rebates of existing windows which has not only provided a new line of work for small joinery firms, but has also encouraged conservation officers to promote it as an alternative to wholesale window replacement because they know that it can be done successfully.

Historic England's tentative support for energy efficiency in listed buildings, providing it does not encroach too heavily on historic fabric appears to have influenced conservation officers in English local authorities. 14% of them either disagreed or strongly disagreed that energy efficiency is important whilst 66% of them agreed, with the provision that full consideration is

paid to the building's capacity to accommodate change. Historic England's reticence towards SPDG has definitely influenced conservation officers in England with 45% of them either disagreeing or strongly disagreeing that SPDG is important in improving the thermal performance of listed buildings (see Figure 7, section 5.2). There are some conservation officers in England who continue to express blanket negativity towards SPDG in listed buildings which is reflective of Historic England's earlier stance. It will be interesting to see whether this changes as a result of the more conciliatory approach in their latest guidance. There are, however, some conservation officers from England who have chosen to adopt a more pragmatic approach to SPDG and to allow Historic Scotland's attitude to influence their decisions. A comment from one conservation officer demonstrates this approach:

"Up until the 2014 Historic England guidance the view of Historic England differed greatly from the view of Historic Scotland, despite being informed by the same technical research from Caledonian University. Research demonstrated that other measures (thermal blinds, shutters etc) could achieve similar U-values to SPDG. Historic Scotland took the view that SPDG was not evil and was ok if it met certain requirements and where this was not possible other measures could achieve similar results. Historic England took the same findings to justify a 'you never need SPDG just buy thick curtains' policy. I fundamentally disagreed with this and applied the Historic Scotland approach (even though I have never worked for a Scottish local planning authority). I note that the 2014 Historic England guidance is now very similar to the Historic Scotland guidance which has been in place for several more years."

In contrast to Historic Scotland, Historic England never encouraged the fitting of SPDG into existing windows. As a result it is an uncommon procedure in England and conservation officers are less likely to see examples of where it is completed successfully. They appear to be confused as to how they should approach retrofitting and also feel constrained by the lack of joinery companies who are prepared to undertake such work (see section 5.5).

Cadw have been restrained in their publication of guidance on windows and a number of Welsh conservation officers have criticised this. They have recently initiated a new project, however, called Heritage Cottage which is measuring the thermal performance of a mid-nineteenth century terraced house which has undergone sympathetic changes to make it more energy efficient. Although it is difficult to draw firm conclusions it does appear that on average conservation officers in Wales are more concerned about energy efficiency in listed buildings than those in England, with 100% of them agreeing that it's important (see Figure 5, section 5.2). They also show greater support for SPDG than conservation officers in England and are less likely to stipulate single glazing in new windows than their counterparts in England (see Figure 7, section 5.2 and Figure 15, section 5.6).

The Welsh conservation officers show themselves to be more receptive to fitting double glazing into existing windows than in England with 100% of them either answering 'yes' or 'in some

circumstances' to the question of whether they'd be more likely to approve retrofitting than an entirely new window (see Figure 14, section 5.5). High profile examples such as the Swansea Guildhall, may have helped Welsh heritage teams see that retrofitting can be successfully achieved. There does seem to be a concern amongst a number of Welsh conservation officers about the longevity of SPDG units.

7 Recommendations

Based on the results from analysis of the survey responses, interviews and planning application databases, this research project makes the following recommendations:

7.1 Publication of guidelines

Local authorities should publish guidelines on the appropriate use of SPDG. Applications to utilise SPDG in listed buildings are increasing and it is important that local authorities have their own published guidelines setting out the circumstances where SPDG is acceptable in buildings in their area. These guidelines should not only cover listed buildings but buildings in conservation areas and other non-listed buildings where the windows are of aesthetic importance. The survey showed that of those conservation teams who responded, 17% of them already have guidelines in place, 10% are in the process of writing them and 73% have no guidelines at all. This should be a matter of urgency as a means of reducing the number of unnecessary applications and appeals and improving the consistency of decisions surrounding SPDG, especially where development control teams have the final say.

7.2 Retrofitting of SPDG into existing windows

Currently, the guidance encourages owners to allow their traditional windows to deteriorate to a point where wholesale replacement becomes the only option. As a result, historic fabric is unnecessarily lost. If local authorities encouraged the retrofitting of slim profile double glazed glass into existing windows, where feasible, then the following benefits would ensue:

1. The lifespan of the windows would be extended because repairs and repainting would be undertaken at the same time. SPDG prevents condensation which is a major contributor to rot in the glazing bars and frames of traditional windows. With the continued reduction in the sightlines of SPDG glass a skilled craftsman can fit thin double glazing into many types of traditional window, as has been demonstrated in Edinburgh.
2. The replacement of glass is far more sustainable than the manufacture of new windows. The wood that was used to construct old windows was slow-grown, often locally produced and, when properly maintained, can last for many hundreds of years. In contrast, modern woods are fast-grown, often shipped from all over the world and have lifespans of less than 30 years. Furthermore, by leaving the frame and sill of the window in place there is significantly less disturbance to the building envelope. With many old dormer windows,

the lath and plaster is attached to the window frame and replacing the whole window fundamentally disturbs the dormer structure and can result in the unnecessary loss of lath and plaster.

3. It would provide small joinery firms with an additional line of business and one which does not require investment in expensive joinery equipment. Conservation officers in England and Wales expressed their concern about the lack of companies willing to carry out on-site repairs to traditional windows. If local authorities and the Heritage Agencies encouraged glass replacement ahead of wholesale window replacement then this would assist smaller joinery firms and encourage them to deploy their resources to on-site window maintenance rather than only focusing on the manufacture of new windows.
4. Inappropriate glazing bars were identified as the greatest problem associated with the use of SPDG in listed buildings – 71% of respondents chose it as their first or second greatest concern. By encouraging the fitting of SPDG glass into existing windows then the problem of poor replication of glazing bar detail is greatly reduced. There are obviously some cases where the original glazing bars are too narrow to accommodate SPDG but Edinburgh City has demonstrated that there are many types of window where retrofitting can be accommodated. A number of conservation officers commented that poor replication of glazing bars in new windows occurs because owners are not prepared to pay for bespoke joinery and instead use large window manufacturers who apply a 'one size fits all' philosophy.

7.3 Incentives to repair and make thermal improvements to windows

There should be grants or tax incentives that encourage repair and upgrading ahead of complete replacement of traditional windows.

At present, the draught stripping of windows is subject to 5% VAT. This reduced rate of VAT could be extended to works that repair and retrofit SPDG in existing windows thereby making the cost of repair/upgrade significantly lower than complete replacement. Local authority grant schemes could include the fitting of SPDG and draught-stripping in their remit, particularly for those buildings where internal or external wall insulation is not appropriate. The Conservation Area Regeneration Scheme (CARS) in Scotland includes slim profile double glazing as one of the improvements eligible for financial assistance. The Haringey Council grant scheme included the retrofitting of SPDG if it was carried out in conjunction with wall insulation. This initiative, however, was hampered by the lack of joinery companies prepared to fit SPDG into existing window frames.

Initiatives for reduced VAT on repairs and renovations have been made by other organisations in relation to carbon emission reductions in existing housing stock. A report by the Environmental Change Unit, Oxford which was commissioned by the Federation of Master Builders recommends that the government establishes a VAT framework for permanent reduced rates on domestic property renovation and repair. They also

recommend financial incentives using council tax rebates as the delivery mechanism (Killip, 2008).

7.4 Improved communications between conservation and energy efficiency stakeholders

7.4.1 Conservation officers and local authority development teams

Conservation officers should view efforts to improve the energy efficiency of listed buildings positively. This does not mean that energy efficiency should take priority over conservation but where it can be achieved without jeopardising the historic, aesthetic and structural integrity of a building then it should be wholeheartedly supported. Many conservation officers already do this but there are some who adopt a hard line towards such changes and as a result encourage the view that listed buildings are uncomfortable and costly places to live and work.

The commitment of conservation officers to energy efficiency improvements may become even more important once the Energy Act 2011 comes into force in April 2018. At this point it will be unlawful to rent commercial and domestic properties that have an energy performance rating below the level of E. It is still unclear as to whether listed buildings will be exempt from these requirements but it will still be important to make energy efficiency improvements to ensure listed buildings do not fall far behind non-listed buildings and become unappealing from an economic perspective. Those conservation officers whose approach is to automatically refuse applications for SPDG in pre-twentieth century listed buildings should rethink their approach. At the very least, they should allow it in modern extensions to listed buildings and in replacement windows where the new window is an aesthetic improvement on the old. SPDG should also be encouraged where the long term viability of a listed building is at risk due to poor energy performance.

The Scottish government's Learning Network Challenge Fund are providing funding for a research project by Changeworks to explore the fitting of SPDG in older properties across Scotland. They aim to review how the policy is working in Edinburgh and look at the scope for extending it to other local authorities in Scotland (Changeworks, 2015). Conservation officers and local authority development teams should pay careful attention to the progress of such projects and consider how the findings from them might be applied in their own area.

7.4.2 Building regulation officers

Building regulators should be encouraged to take greater interest in listed and traditionally constructed buildings. In England and Wales the exemption from complying with Part L of the Building Regulations is not meant to encourage a disregard for U-values in listed and traditionally constructed buildings but it invariably does. As one conservation officer

noted, “The 'advertised' enhanced U-value of slim double glazed units is the only reason for choosing them over single glazing,” and therefore there should be more dialogue between building regulators and conservation officers to ensure that when changes are made to the windows of listed buildings the U-values are more of a consideration. This should not only be the case with SPDG but also where single glazing is required. Special single glazing is now available with improved U-values, for instance Histoglass Mono which has a U-value of 3.6 W/m² compared to the U-value of 5.4 W/m² of standard single glazing. The U-values of windows in historic buildings may be considered more important when the Energy Act 2011 comes into force because they can contribute significantly to an improved energy performance rating.

7.4.3 Manufacturers of slim profile double glazing

SPDG manufacturers should go to greater efforts to communicate developments in their product to conservation officers and development teams and make it easier for them to stay up-to-speed with improvements. For example, samples of SPDG with ‘historic’ glass or reduced tint should be sent to heritage teams. If conservation officers are more familiar with the different types of SPDG available then they might be more supportive of it and also make their consents conditional on the use of glass types that are more in keeping within an historic context.

Greater demand for specialist types of SPDG will encourage more glass producers to manufacture it which, in time, will bring down the price. The Heritage Agencies and conservation officers should make SPDG manufacturers aware of the elements of their product that make them concerned about its use in listed buildings, for instance, the lifespan of SPDG units.

SPDG manufacturers should undertake more research into the longevity of SPDG with the aim of offering the same guarantees as on conventional double glazing. At present only a few makes of SPDG comply with all six parts of the British and European Standards controls for insulating glass units (BS EN 1279). If an SPDG unit complies with these standards then it means that it has been long term tested for gas leakage, moisture penetration, gas concentration tolerance and edge seal longevity. More SPDG manufacturers should undertake this testing on their slim line units which will then help allay the concerns of conservation officers and the Heritage Agencies over their lifespan

7.4.4 Joinery companies

Joinery companies should be encouraged to undertake work involving the on-site repair and glass replacement of traditional windows rather than focusing purely on the manufacture of new windows. This has been achieved to a greater degree in Scotland where the CARS scheme provides training and education opportunities in traditional craftsmanship. Furthermore, Historic Scotland are opening The Engine Shed in 2016 which

will be a centre for the training of skills necessary for the conservation and regeneration of old buildings. Schemes like this encourage the retention of traditional skills ensuring that specialist craftsmen are available to undertake conservation work.

Another positive development in Scotland is that some local authorities use trusted joinery firms to assess the condition of traditional windows ahead of granting or refusing consent to their replacement. They are also able to assess whether a window can accommodate SPDG glass instead of wholesale window replacement.

There are a few joinery companies in England who install SPDG into existing traditional windows such as CR Carpentry and Envirosash. They should make efforts to demonstrate to conservation officers how SPDG can be successfully fitted into most single glazed period windows.

7.4.5 The Heritage Agencies

Historic Scotland has led the way in commissioning research into the use of SPDG in traditional windows. From an early stage they adopted a cooperative approach towards its use and have seen it as one of a number of ways of improving the energy efficiency of traditional buildings. In Edinburgh, in particular, it has been utilised as a means of reinstating uniformity in Georgian terraces because owners have been encouraged to reinstate astragals when replacing their Victorian style windows.

Historic England has recently softened their previously hard line but should do more research into the retrofitting of SPDG glass into existing frames. England and Wales need to support the traditional joinery industry so that craftsmen are available to undertake repair works to windows. Encouraging the retrofitting of SPDG adds another line of business for small joinery companies. Cadw has traditionally piggy-backed off advice from Historic England but a number of Welsh conservation officers expressed their desire for Cadw to provide more explicit guidance on SPDG in listed buildings.

8 Summary and conclusion

Listed buildings are at the core of Britain's history and culture, adding immeasurably to its success as a tourist destination. They are also privately occupied homes, work places and part of the portfolios of many housing associations. In a world of increasing energy prices and carbon emissions, reducing heat loss from listed buildings is vitally important to ensure their continued occupation and secure their long term survival.

Windows invariably add to the special character of a building and are very often of historical importance in their own right. In pre-twentieth century buildings they can also be the component that performs worst thermally compared to the rest of the building envelope. The advent of slim profile double glazing provides the opportunity for the heat loss from windows

in listed buildings to be reduced, on average, by 63%¹. But there is a necessity to ensure that it doesn't lead to the loss of historic glass; damage the beauty and uniqueness of listed buildings; or lead to the indiscriminate replacement of serviceable windows.

This research project has used three methods of quantitative and qualitative data collection to find out how conservation officers across the UK view slim profile double glazing in the context of listed buildings. It has discovered that as well as there being some similarities in approach there are also some stark differences. This leads to a general confusion and annoyance amongst listed property owners where consent for SPDG is granted in some regions but not in others.

Conservation officers are strongly influenced by guidance from Historic England and Historic Scotland. Historic Scotland's more pragmatic approach to SPDG, particularly in relation to the retrofitting of SPDG glass, has encouraged a more liberal stance amongst Scottish conservation officers (and some English and Welsh conservation officers). Historic England's reticence towards SPDG is reflected in the approach of many conservation officers operating in England and Wales although there is evidence of a softening of opposition.

The aim of the research project has been achieved but there are clearly local authorities whose approach has not been recorded, in particular, those where the development team deals with listed building consent applications. Further research could be carried out on more planning application databases to reflect the approach of local authorities that did not contribute to the survey. Additional research should be carried out on the possibilities and pitfalls of incorporating SPDG glass into existing windows especially looking at how this has been achieved in Edinburgh.

To offer a final summary on how SPDG could be incorporated into listed buildings to improve thermal comfort levels and reduce energy consumption the following points are made:

1. There are clearly many windows in listed buildings that should be preserved in their entirety and where SPDG should never be permitted.
2. There are some buildings where a combination of SPDG and single glazing may be appropriate.
3. The modern extensions of listed buildings should contain SPDG or, in some cases, even normal double glazing.
4. SPDG should be permitted in replacement windows where there is an improvement in form from the incumbent window.
5. In windows at the back of buildings which have undergone alteration.

¹ Based on an average centre of pane U-value of 2.0 W/m² K for SPDG. Some SPDG units have a U-value as low as 1.0 W/m²K, in which case the heat loss reduction would be 81% (Baker and Heath, 2010)

6. In listed buildings where SPDG will help secure its long term survival such as buildings owned by housing associations and in conservation area regeneration schemes.

Conservation officers should be prepared to encourage the retrofitting of SPDG glass into existing frames as a means of preserving historic joinery. Further research on this should be carried out by Historic England to facilitate this more sustainable option. Conservation officers should also consider the option of historic or conservation glass before dismissing SPDG proposals because of proximity to other single glazed traditional windows.

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10 Appendices

Appendix A: Questionnaire delivered electronically via SurveyMonkey