



Preserving Australia's Stained Glass Windows: Shedding Light on Best Practice Stained Glass Restoration and Conservation Techniques

Rebecca Kythe Boehme

Mason Family Trust Fellowship, 2026

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Table of contents

01	Acknowledgements	1
02	Executive Summary	3
03	Fellowship Background	4
04	Fellowship Learnings	9
05	Personal, Professional and Sectoral Impact	37
06	Conclusion	39
07	Appendix	40
08	References	47

01

Acknowledgements

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02

Executive Summary

What does the future of stained glass look like in Australia? A question that Mason Family Trust Fellow Rebecca Boehme approached with both uncertainty and optimism.

The Fellow hopes that through this fellowship, they can play an active role in shaping the future of stained glass in Australia. That their research will contribute to the ongoing advancement of stained glass conservation and restoration practices in the country.

After completing a Certificate III in Glass and Glazing at Melbourne Polytechnic, the Fellow has worked as a traditional tradesperson in stained glass studios across Melbourne for the past five years, developing a particular interest in stained glass restoration, conservation, and stained glass painting. The Fellow was awarded the Mason Family Trust Fellowship in 2025 by the International Specialised Skills Institute, and as part of this program, undertook a six-week study visit to England. During this period, the Fellow visited The York Glaziers Trust, Jonathan Cooke, Barley Studios, attended the British Society of Master Glass Painters conference and finally completed their travels at Lamberts Glass Factory in Waldsassen, Germany.

This report presents the research, observations, and findings arising from those travels, offering insights and recommendations into the following key areas:

Firstly, the Fellow researched conservation standards, industry accreditations and career pathways in England, researching how these structures differ from Australia and influence industry growth and the engagement of new professionals.

Secondly, the Fellow will present updated information and practical insights into best-practice principles and methods in stained glass conservation and restoration across England and Europe, encouraging practitioners in Australia to continue undertaking the highest standard of work in this field.

Finally, the Fellow intends for their research into the implementation of Environmental Protective Glazing Systems to be both insightful and informative to those entering, currently practising, or otherwise engaged in Australia's heritage community.

03

Fellowship Background

Fellowship Context

The evolution and preservation of stained glass both in Australia and internationally, greatly depends on the dedication of master craftspeople, industry professionals, and emerging apprentices. These groups and individuals have already gained widespread respect for the decades of work they have put into moulding Australia's Glass identity to what it is today. However, despite the continued passion of these dedicated groups and individuals, glass in Australia has experienced periods of both growth and stagnation throughout its modern history.

We are lucky as a nation to boast a wonderful collection of stained glass, including both imported and locally made ecclesiastical stained glass windows, as well as an abundance of residential stained glass and leadlight in Victorian, Edwardian, Art Deco, arts and crafts and contemporary style. However due to the enormous scope of this subject, the Fellow's research and reporting will be largely focused on responding to the emerging and ongoing issues evident in 19th century painted stained glass within Melbourne, Victoria.

To give a brief background of 19th century stained glass in Australia, the Fellow interviewed Dr. Bronwyn Hughes. Dr. Bronwyn Hughes is the president of Glaas Inc, an art historian and independent scholar with research interests in stained glass history and conservation, 19th century art and architecture and 20th century sculpture.³ In conversation with Dr. Bronwyn

Hughes, the Fellow gained an understanding of the history of Australia's 19th century stained glass, as well as the current context which precedes and necessitates the Fellow's research.

Through the 1880's, wealth was being brought to the British colonies through the gold rush and with the growth of major cities, stained glass was first imported to major Melbourne cathedrals from England. Stained glass windows were sent over from English studios, including windows sent to St Paul's Anglican Cathedral from Clayton & Bell London, and to St Patrick's Catholic Cathedral from Hardman and Company of Birmingham, (Hardman and Co).

St Patrick's Catholic Cathedral in Melbourne houses some of Australia's oldest and largest examples of painted ecclesiastical stained glass, imported from Hardman and Co. Most notable being the Great West Window. This window illustrates the 'Ascension of Our Lord' and was installed in 1867 as a memorial to Father Patrick Geoghegan, Melbourne's first priest.⁴

During this period there was an increase in demand for locally made decorative glass. One of the most notable producers of stained glass in this time were James Ferguson and James Urie. James Ferguson and James Urie were two Scottish men who immigrated in 1852, establishing the glass studio 'Ferguson and Urie,' in 1853 in Melbourne. Stained glass windows produced by Ferguson and Urie date back to the early 1860's and are still in Churches and private collections across Australia

today. Ray Brown, an expert of the studio notes, “There are currently 238 locations across the east coast of Australia, with one or more extant windows from west to Adelaide SA, north to Rockhampton QLD, south to Hobart TAS and as far east as 8 places in New Zealand. Victoria holds the (majority) of Ferguson and Urie stained glass.” With the death of James Urie in 1890, Ray Brown’s research shows that with, “Increasing competition in the stained glass trade along with the stock market crash in 1890...undoubtedly (took) a toll on the business... Advertisements for Ferguson & Urie began to decline in the latter half of 1892 and then ceased to appear altogether.”⁵ Following this decline, Ferguson and Urie had ceased to exist past the early years of the 1900’s.

Through this brief description of a selection of Melbourne’s 19th century stained glass, it is evident that there are a notable number of historically and culturally significant imported and locally produced stained glass windows still on display throughout the state today. 19th century stained glass windows produced during this period continue to require specialised restoration of fragile paint, paint loss, the edge-bonding of broken pieces, the re-leading of deteriorating lead and the addressing of instances of vandalism. These issues form the basis of the Fellow’s international research and underscore the need for ongoing restoration and conservation skills to ensure the protection of such glass into the future.

Fortunately, despite historical periods of decline and resurgence, Melbourne is currently experiencing a revival in glass, with an influx of skilled glass artists and tradespeople entering the field over the past 5 years. This is an encouraging development driven by the introduction of the Certificate 3 Glass and Glazing and the Diploma of Visual Arts (Glasswork) at Melbourne Polytechnic, both courses developed and driven by Glaas. Inc executive director Donna Kennedy. The creation of this course has allowed skills to be shared, passions nurtured and careers built. Only 5 years after its inception, the course has grown from 12 places in 2020 to offering over 80 places in 2025. These numbers are a testament to the success of

this course, and an indication of the future output into the industry. The Fellow is fortunate to be a part of this new cohort of practitioners emerging from this pathway, most of whom are committed to advancing glass to the forefront of art, architecture and design. The Fellow recognises the role Donna Kennedy and Melbourne polytechnic’s support has played in leading them to their current position.

Fellowship Methodology and Period

With the aim to address the concerns evident in Melbourne’s 19th century stained glass, the Fellow embarked on a 6 week journey to England, Scotland and Germany, with the goal to research and report on best practice European stained glass restoration and conservation techniques, and how they may be dispersed and implemented more widely across Australia.

The Fellow began their fellowship in York, England, spending 2 weeks on a studio placement at the York Glaziers Trust. York Glaziers Trust is the oldest and largest specialist stained glass conservation studio in England. It operates as an independent charity, committed to both the restoration and conservation of York Minster’s windows, as well as preserving historic stained glass across the country. York Glaziers Trust provides a comprehensive range of services, including the conservation, repair, and protection of stained glass all the way back from the medieval period, to 20th century stained glass windows. York Glaziers Trust now employs 16 staff, including 3 ICON accredited conservators.⁶ During the Fellow’s placement, they spent time working alongside a team of conservators on current restoration and conservation projects, including having the opportunity to view the on-site restorations at York Minster. The Fellow spent dedicated time learning alongside ICON accredited conservator Sophie Gwynne, Team Leader/Conservator, Anna Milsom and conservator Sarah Shepard. The Fellow also wishes to thank Director Dr Marie Groll and Sarah Brown, for kindly accepting them for this two-week placement, and for their ongoing support and guidance throughout their time at the York Glaziers Trust.



Figure 1. The Fellow during their placement at York Glaziers Trust (photo courtesy of York Glaziers Trust)



Figure 2. the Fellow on site at York Minster viewing Environmental Protective Glazing

Remaining in York, the Fellow completed a three day glass painting workshop with Jonathan Cooke. Jonathan Cooke is a stained glass artist, tutor, ICON accredited conservator and specialist assessor for ICON's accreditation scheme. Over several decades Jonathan has experimented, developed and pioneered multiple layering techniques with essential oils and other media, releasing several books on the subject, including 'Time and Temperature', 2013, and the second edition, 'Time and Temperature,' 2025.⁷ During this workshop the Fellow learnt several techniques pioneered by Jonathan, and spent dedicated time alongside Jonathan discussing the issues facing Australian stained glass, including the unique factors affecting paint loss and how best to address these problems.

To conclude their time in York, the Fellow undertook a ten day studio placement with Barley Studios. Barley Studio specialises in the creation and conservation of stained glass windows in cathedrals, historic estates, parish churches, and prominent secular buildings across the UK and abroad. Under the leadership of Directors Keith Barley and Helen Whittaker, the multidisciplinary team carries out all work in-house at the studios in York.⁸ While on placement with Barley Studios, the Fellow spent much time developing their understanding of stained glass conservation practices alongside ICON accredited conservator and restorer Alison Gilchrist, as well as time spent investigating the production of different environmental protective glazing systems. The Fellow was also very grateful for the time spent with Helen Whittaker, gaining insight into stained glass design and glass painting systems. The Fellow was also appreciative of the time spent with Keith Barley, touring the historic city of York to learn about Barley Studio's restoration projects and the implementation of environmental protective glazing systems. These placements were further enriched by a number of on-site visits to observe both current and historic stained glass works at locations across York, including Holy Trinity Goodramgate, All Saints North Street, St Martin's, St Helen's, and the Merchant Taylors' Hall.



Figure 3. The Fellow during their placement at Barley Studios

Following this period of studio placements, the Fellow also visited York Minster, Durham Cathedral, Winchester Cathedral, Ely Cathedral and the Ely Stained Glass Museum. As well as these locations across England, the Fellow also visited the vast collection of stained glass at the William Burrell Collection, Scotland.



Figure 4. The Fellow during their visit to the Burrell Collection, Glasgow, Scotland

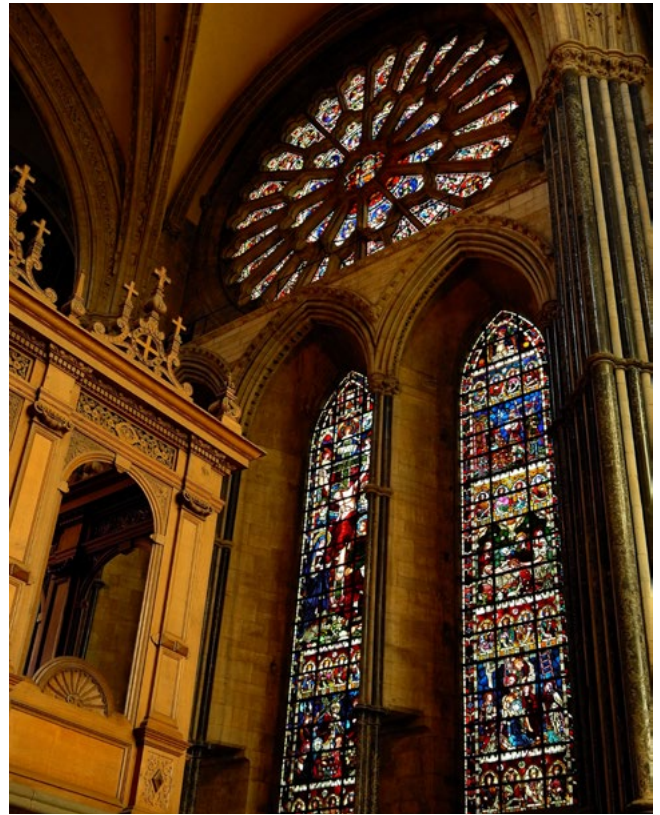


Figure 5. Durham Cathedral, Durham, England

The Fellow completed their time in the UK by attending the British Society for Master Glass Painters three-day annual conference in Winchester. The British Society for Master Glass Painters is the UK's trade association dedicated to the art and craft of stained glass and supports professionals involved in glass painting and staining across England. Attendance at this annual conference provided a great opportunity for the Fellow to participate in tours, lectures and presentations all focused on the vast history and current landscape of English stained glass. This was also a valuable opportunity to form personal and professional connections with stained glass artists from across the UK.

The Fellow's final fellowship stop was in Waldwassen, Germany. Here the Fellow visited Lamberts Glass factory, the largest producer of hand-made, mouth blown antique glass in the world. Lamberts Glass produces genuine, handmade, mouth-blown antique glass. Their team of over 70 skilled master glass blowers and tradespeople use traditional techniques and

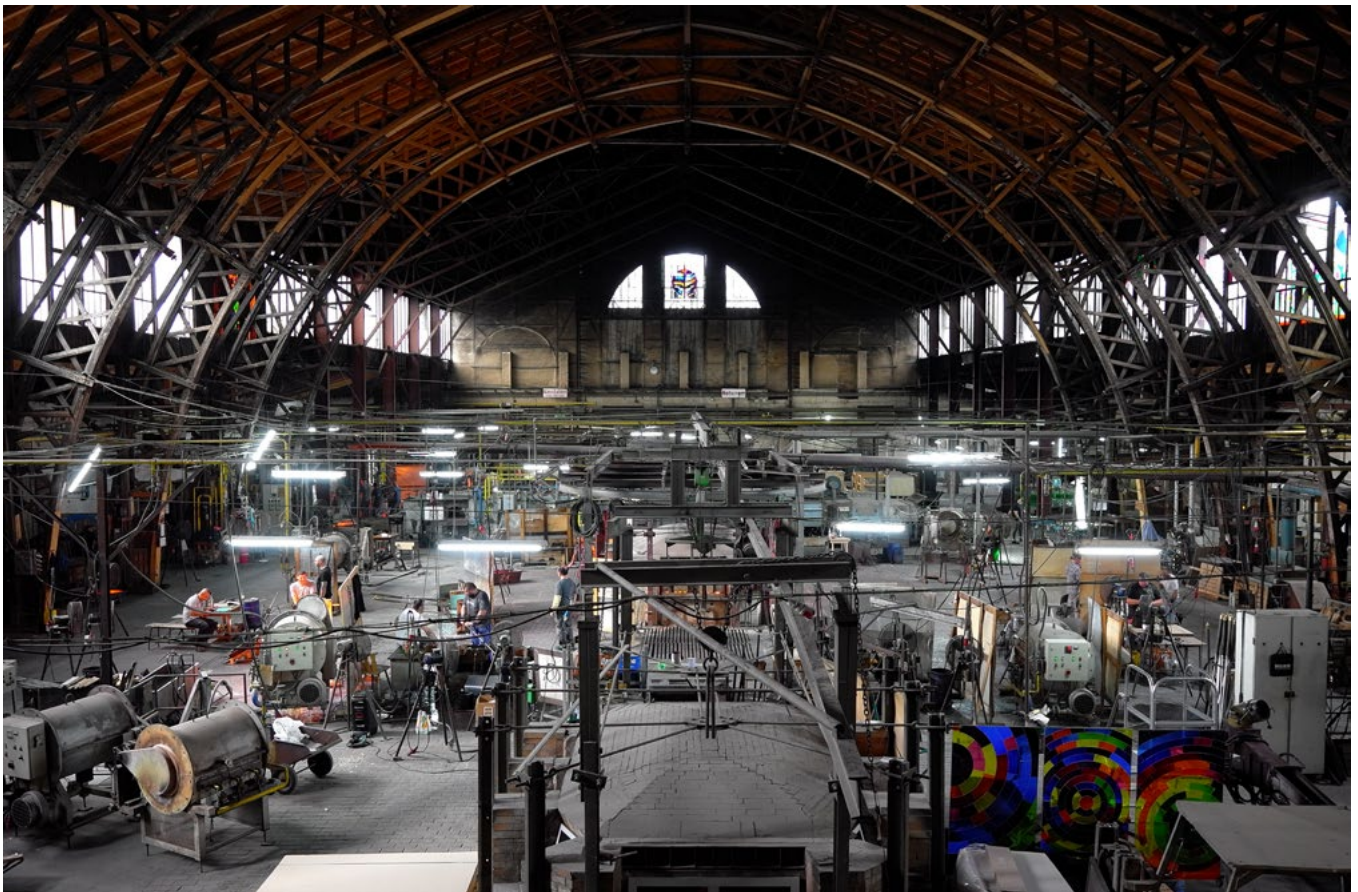
methods that have been practised and preserved for centuries. During the factory visit, the Fellow was given a comprehensive overview of the entire glassmaking process, gaining a rare opportunity to observe each stage of production, including observing the melting of raw materials, glass blowing, annealing, storage and transport of the antique glass product.

Fellow Biography

After completing their Certificate 3 in Glass and Glazing at Melbourne Polytechnic in 2020, the Fellow pursued on-the-job training and gained experience through employment at glass studios across Melbourne. Through this time, the Fellow developed a particular interest in leadlighting, traditional stained glass painting, heritage glass, stained glass restoration, conservation and the history of stained glass across Victoria. In pursuit of advancing these skills, the Fellow was led to their current workplace, Almond Glassworks in Melbourne, Australia.

For the past 4 years, the Fellow has had the opportunity to receive valuable experience as part of a team working on a multitude of ecclesiastical and residential projects. Through this period, the Fellow also gained important insight into Melbourne's stained glass collection and began to identify emerging challenges facing the future of these windows. These challenges included restoration issues arising in windows produced from both Hardman and Co. and Ferguson and Urie studios. This generated a particular interest for the Fellow and deepened their passion in the field, inspiring them to pursue further international research on these subjects.

Figure 6. Lambert Glass Factory, Waldsassen, Germany.



04

Fellowship Learnings

Industry Standards, Accreditation, Education and Pathways.

In this section, the Fellow will present their findings on the industry standards, accreditation, and educational pathways in England that guide glass practitioners in the restoration and conservation field in England. These include the Corpus Vitrearum (CVMA) guidelines, The Institute of Conservation (ICON) accreditation and a discussion of the university degrees and further education available to individuals interested in working within the field of stained glass conservation.

Corpus Vitrearum

To accurately summarise the Corpus Vitrearum (CVMA) guidelines, the Fellow references the introduction of the CVMA which states in section 1.1 that “The Corpus Vitrearum is a set of guidelines outlining the ethical principles underlying the conservation and restoration of stained glass of all periods. They serve as a reference for conservators/restorers and consultants, as well as an introduction and source of information for individuals and organizations responsible for the preservation of stained glass.”⁹

The organisation may be referred to either as CVMA (Corpus Vitrearum Medii Aevi) or Corpus Vitrearum (International) with no notable difference between the projects at this point in time. Initially, The CVMA originated as a collaboration of international scholars who were organised into

national committees, holding the primary aim of documenting medieval stained glass. Over time, additional countries sought membership, including those with relatively limited medieval stained glass but often with substantial amounts of nineteenth-century stained glass. In response, the organisation adopted the broader designation Corpus Vitrearum, omitting the explicitly medieval terminology in order to reflect this expansion. The Corpus Vitrearum international committee drew up the ‘*Guidelines for the Conservation and Restoration of Stained Glass*’ first edition Vienna 1989 and second edition Nuremberg 2004. Though as the Corpus Vitrearum guidelines were written approximately 20 years ago, they remain the most appropriate and authoritative framework for current practitioners.

Key elements outlined in the most recent, second edition, Nuremberg 2004 CVMA guidelines include practices and principles regarding:

- Research and documentation
- Preventative conservation, Protective Glazing, handling, transportation, storage and display,
- Interventive Conservation and Restoration; Access, Conservation in Situ and treatment before removal, treatment of glass surfaces, treatment of missing areas and later additions and structural consolidation.

Through studio placements at the York Glaziers Trust and Barley Studios and their attendance at the British Society of Master Glass Painters Conference, the Fellow observed firsthand the value of the CVMA framework in guiding

methodology for stained glass conservation and restoration projects across the country.

Not only does the CVMA act as a trusted source of best practice guidelines, it also fosters community, connection, and continued education through its online databases, archives, membership and member conferences. Part of the online archives for the British Corpus Vitrearum members includes a catalogue of relevant academic and scientific papers covering a wide range of restoration and conservation topics. More widespread knowledge and access to this type of information would only be beneficial to Australian practitioners, and instrumental in increasing awareness of the historical research and current developments within stained glass restoration.

In Australia, there are a small number of practitioners who are active within the CVMA community, however there is no formal commitment to the guidelines, or general familiarity with this framework across the country. More commonly referenced by industry professionals is the International Council on Monuments and Sites (ICOMOS) Burra Charter, which does not tailor guidelines specifically for glass, but "Sets a standard of practice for those who provide advice, make decisions about, or undertake works to places of cultural significance, including owners, managers and custodians."¹⁰

Similarities between the CVMA and Burra Charter include firstly the respect for the original fabric of the work or place, with both documents advocating for the retention of as much original material as possible and minimal intervention. Secondly, both standards focus on the need for thorough research and documentation as well as understanding a place or work's significance, fabric and setting before decision making and intervention. Finally, both frameworks advocate for conservation as an ongoing process, highlighting the importance of monitoring and maintenance ensuring the ongoing protection of both works and places.

Differences between the CVMA and Burra Charter include the level of detail, the scope of the

guidelines and how they are applied. The Burra charter acts as a much broader set of guidelines, providing a framework to apply to places of cultural significance, however it does not go into detail about technical practices or the specific methods for the restoration and conservation of these places. In comparison, the Corpus Vitrearum guidelines are much more specific, setting out technical and practical guidelines specific to glass.

In conclusion, it is the Fellow's opinion that both consideration of the Burra Charter and CVMA is integral when undertaking the restoration of stained glass in Australia. While both support minimal intervention and respect for original material, an understanding of the Burra Charter is essential in order to account for the broader impact of restoration work on the building as a whole. Stained glass windows may only form one component of a wider conservation project, and the cultural significance, context, and setting of the location in which the glass exists, must be carefully balanced alongside the necessary conservation of the glass itself. Within this broader framework, the Burra Charter provides guidance on contextual and heritage considerations within Australia, while the CV offers direction on appropriate stained glass conservation techniques, handling, materials, and documentation throughout the restoration process.

Accreditation

The Institute of Conservation (ICON) is a charity established with the vision to, "protect, preserve and promote our treasured cultural heritage through cultivating skilled conservation professionals, supporting meaningful collaboration across the cultural heritage sector, and delivering public benefit through engagement and advocacy."¹¹ ICON accreditation is awarded to practising professionals in the field of conservation, formally acknowledging practitioners skills and experience in conservation through peer review. With approximately 2,300 members, ICON is organised into dedicated groups established for each conservation discipline, including stained glass. In Australia there is no current formal accreditation like that offered by ICON, with the scope of work and the selection

of practitioners for any heritage restoration or conservation projects typically in the control of heritage architects.

In order to gain accreditation, candidates are normally expected to have a minimum of five years post-qualification professional experience following a recognised conservation degree. Those without formal academic qualifications in conservation, but who have trained through professional practice, are typically required to have between eight and ten years of relevant experience before gaining accreditation.

The accreditation process begins with the submission of an application which is reviewed by a panel of appointed Accredited Conservator-Restorers (ACRs) to determine whether the applicant is ready to proceed to full assessment. Eligible candidates then undertake a professional practice assessment based on the preparation and submission of a portfolio of evidence, followed by a professional discussion with the Assessor and Specialist Advisor.

All assessment materials are subsequently reviewed by the Accreditation Moderation Committee, after which the applicant is formally informed of the outcome. This process ensures, as it does in every field of ICON conservation, that practitioners are assured to be qualified, using updated best practice methods and working to the highest technical standard.

In conversation with Dr. Marie Groll, Director of York Glaziers Trust, Marie Groll speaks in support of the accreditation system, “The ICON system has been very effective...before this, it was very hard to understand the competency of a stained glass worker.”

In addition to awarding accreditation in recognition of high professional standards, ICON also maintains a register of its accredited members. This directory helps parties to verify whether a conservator holds accredited status with ICON, and the *‘Find a Conservator’* directory further enables private clients, museums, architects, and custodians of historic buildings to connect with

professionally accredited conservation practitioners across England and internationally.

In Australia, the means of identifying qualified practitioners is currently less centralised than the ICON accreditation and directory. There are many different directories for heritage architects, tradespeople and practitioners working within conservation, including both a national directory and at least one directory for each separate state. However, they generally include very few listings of stained glass professionals operating in that state. For example, the ‘Victorian Heritage Services Directory’, the ‘Heritage South Australia List of Trades and Consultants,’ and the ‘Tasmanian Heritage Services Directory’ all have just one stained glass studio listed in their directories. Western Australia’s online directory ‘find a heritage specialist’ has two studios listed, while both Queensland and the Northern Territory do not have a directory for heritage tradespeople or architects. One reason for this is that maintaining a listing in such a directory can be expensive for a practitioner. Marie Groll comments that this is also an issue with ICON accreditation, “The searchable register is great too for the public...(however) you have to pay a lot to appear on it fully. Which means that it doesn’t show everyone who is accredited.”

However, it must be noted that through both Dr Bronwyn Hughes and Donna Kennedy’s work, the resources and community fostered through Glaas Inc. help address several of the gaps previously identified in Australia. Membership with Glaas Inc. provides Australian practitioners across all glass disciplines with access to a strong professional community, as well as events, lectures, presentations, and online resources relating to glass practice in Australia. In terms of consultation, the organisation also offers guidance by directing enquiries to professional conservation services.

Regardless, it currently stands that the ways in which the public and professionals can research, compare, and determine suitability for a stained glass restoration project is less comprehensive than in England and at the least, leads to reduced visibility, recognition and engagement for

Australian glass practitioners and studios. While there have been attempts in the past to create a more specific type of accreditation for Australian stained glass practitioners, none have eventuated. ICON accreditation is available to international practitioners in all conservation fields, including stained glass. The Fellow discusses this possibility in the recommendations section of this report.

Education and Pathways

In England, there are many pathways for individuals who are interested in developing a glass studio practice or a career in the stained glass restoration and conservation field.

Offered by *The University of York*, The Master's program in Stained Glass Conservation and Heritage Management, provides in-depth teachings and practical experience with current conservation practices. The masters program is offered as a two-year course consisting of modules, a twelve-week studio placement with a leading conservation studio, museum, or heritage institution, and an additional five-month dissertation.

Another opportunity offered is from *Swansea College of Art*, which provides comprehensive opportunities for the study and practise of glass within its Design Crafts BA programme. At the postgraduate level, Swansea offers a Master's in Glass that enables students to pursue the techniques and processes that suit their individual artistic explorations and direction. Beyond formal degree programmes, Swansea College of Art also offers a structured three-year stained glass apprenticeship to those who meet specific entry requirements. While the Fellow did not get the chance to visit Swansea College of Art during their visit to England, they were able to meet and discuss these opportunities with both educators and apprentices taking part in the above programs at the British Society of Master Glass Painters Conference.

In addition to these opportunities, the *Worshipful Company of Glaziers and Painters of Glass*, offers awards, scholarships, and competitions, including a 40-week Award for Excellence and a 10-week Ashton Hill Award, giving emerging glass artists

and conservators practical studio experience and industry contacts. *The Society for the Protection of Ancient Buildings (SPAB)* also offers a 6-month fellowship funded by the UK government and lastly the 'Chemistry for Conservators' is a distance-learning course providing foundational knowledge in conservation principles, materials, and scientific processes.¹¹

A key difference between these examples and the courses available in Melbourne is that several of these opportunities offer placements or apprenticeships that are integral to the structure of each course. This ensures that the skills being taught within these institutions are being reinforced through on-the-job learning. For example, the inclusion of a formal 12 week placement or 3 year apprenticeship provides in-depth, practice-based training aligned with industry standards. This opportunity helps bridge the gap from completing a practical course to gaining professional training and employment in traditional glass studios.

In Melbourne it is a positive sign that students who graduate from the Certificate 3 in Glass and Glazing or the Diploma of Visual Arts (Glasswork) at Melbourne Polytechnic are already gaining employment in the industry. Dr. Bronwyn Hughes comments on this success, "The employment of graduates in studios is strong, with the remainder setting up their own studios and/or taking up opportunities for teaching in the GLAAS Inc workshop program, or undertaking TAE training to join the TAFE work force." The rise in employment resulting from these courses can only be seen as a positive development. Nonetheless, the Fellow has observed a growing gap over the past five years between course completion and the transition into long term employment within traditional glass studios and the conservation field. This gap is not for lack of trying or enthusiasm, but may be due to a range of contributing factors.

Primarily, unlike education pathways in the UK, the current courses in Australia do not have these established studio placements or apprenticeships available as an ongoing program once the course or diploma has ended. While the popularity of the Glass and Glazing Cert 3 and Diploma have surged

in the past 5 years, due to overall student numbers and costing there is currently no traditional apprenticeship program offered through existing Australian training or apprenticeship organisations. While apprenticeships are available within mainstream glazing trades, none currently run that are specifically tailored to stained glass practice.

This gap is further influenced by the far greater concentration of ageing historic buildings in England compared to Australia. As a result, there is significantly higher demand for workers with skills in traditional trades, creating more established training pathways that are often supported by government funding and heritage initiatives.

Finally, it would be remiss for the Fellow not to mention that with the success of the course, it can be assumed that the opportunities for current students hoping to gain experience in stained glass restoration or conservation may find it difficult due to the number of graduates compared to the number of operating studios in Melbourne. The presence of stained glass in Australia is much less than that of the UK, resulting in a smaller number of operating practitioners, with an even more limited number of traditional stained glass studios practising stained glass painting, and heritage glass conservation. This leads to fewer pathways for graduating students hoping to progress further in this direction.

However, the disparity between the number of graduates and traditional studios does not imply a complete absence of demand for skilled workers. Entering any traditional trade requires a sustained period of dedication and commitment from both mentor and apprentice and cannot be realised in a short timeframe. Increasing the visibility of these roles, and encouraging practitioners in traditional studios to mentor graduates is an important step toward creating stronger pathways for masters and apprentices. This will help ensure meaningful professional relationships are established early, allowing emerging practitioners time to develop specialised skills before the existing generation of experts transitions out of the workforce.

Restoration and Conservation.

Conservation Principles

In their 1999 research report “*Conservation: Materials and Methods*,” published by the Corpus Vitrearum in 2000, Jägers, Römich, and Müller-Weinitsche research both historical and contemporary materials and techniques used in stained glass restoration and assess their effectiveness in preserving stained glass paint.¹² In their conclusion, the authors consider fundamental principles that should guide restoration practice. These principles do not solely apply to the restoration of stained glass paint but to all elements of a stained glass window including the glass, lead matrix, putty and surrounding masonry. In principle, these values are also advocated for by the CVMA and the Burra Charter, and act as the foundation for the Fellow’s research and reporting in the following sections. In summary, these include:

-Minimal Intervention and Maximum Preservation:

Any conservation and restoration practice should follow the principle of minimal intervention and maximum retention and respect for original material. There may be a case for intervention when existing material is not original, but part of a previous restoration but such intervention should be considered on a case by case basis. However generally, depending on the condition, retention of material that may be part of a previous restoration should still be respected and preserved in its existing state.

-Focus on preservation, not replacement:

Any restoration intervention should primarily attempt to protect and stabilise any deteriorating original material that remains, not to return such elements to their original appearance.

-Restoration as a last measure:

Actions such as replacing glass pieces, completing panels, or retouching paint should occur only in exceptional cases and must be supported by thorough justification.

-Conservation takes priority:

Restoration should be secondary to conservation, as it is often the case that once original material has begun deteriorating, it becomes much more complex to address.

In the next sections, the Fellow discusses paint loss, enamel loss, and the possible causes of this of deterioration in both the UK and Australia. These factors including climate, the composition of the pigments and flux in the paint, the thermal expansion properties and composition of the glass, the quality of the paint preparation and the accuracy of the temperatures reached in the firing process.

The Fellow will also highlight specific instances of paint loss in Melbourne, and demonstrate how conversations with leading ICON accredited conservators in England have informed strategies for addressing these cases.

Finally, the Fellow will provide a broad overview of technical treatment options for paint loss, including paint consolidation with acrylic resins, the application of cold colour and plating methods, along with related restoration practices including edge-bonding, the treatment of microbial growth, and glass corrosion.

Paint Loss

As mentioned in the introduction, the Fellow entered into this fellowship with a particular interest in the paint loss exhibited in 19th century stained glass windows in Australia, and pursued the issue in England to further investigate.

In its most basic form, stained glass paint is a mixture of low melting ground glass (flux) and metal oxides (pigments.) This mixture can be combined with a variety of different mediums including but not limited to water, lavender/clove oil, gum arabic and vinegar to form a paint-like consistency. Once applied to the face of the glass and fired to temperature in a kiln, (usually between 580 degrees celsius and 650 degree celsius,) the finely ground glass in the paint mixture melts and fuses to the base glass, securing the fired paint. Glass painting techniques, paint mixtures, mediums, firing

techniques, temperatures and schedules have varied widely throughout history. While variations may have a minimal impact on the final result, other changes may have a significant effect on the deterioration of paint years or even centuries later.

Paint loss is defined as stained glass paint that is either 'flaking', 'powdering' or 'pinpricking' away from the base glass. **Flaking** refers to when micro-cracks in the paint layer are penetrated by moisture, causing an area of paint to peel off in flakes. **Powdering** refers to the widespread corrosion of a whole fragile paint layer that has no visible flakes or areas that are actively peeling. **Pinpricking** is defined by small, 'pinprick' dots of light where paint has begun to become detached and light is beginning to shine through the face of a painted surface. Paint loss and enamel loss in 19th-century stained glass windows is an issue that is not isolated to English stained glass, with many 19th century stained glass windows from studios across Europe, America and Australia suffering a similar fate.

Paint loss can result from issues related to glass composition (including the thermal properties of the glass), paint composition, paint preparation, and firing inaccuracies. Poor adhesion of glass paint to the glass due to any of these factors increases the chance of paint loss, something which is accelerated by poor environmental conditions. These causes and conditions are discussed in further detail in the following sections of this report.

Enamel Loss

As well as glass paint loss, **enamel loss** is also a serious issue facing historical stained glass. The Fellow had the opportunity to work as part of a team at York Glaziers Trust restoring an 18th century panel by William Peckitt that displayed extensive enamel loss. Like paint loss, enamel loss can also occur for a variety of reasons including inadequate firing temperature and paint preparation. The fellow learnt that another possible cause is incompatibility between the coefficients of thermal expansion (CTE) of the enamel and the base glass. CTE refers to how much a material expands and contracts following

changes in temperature, meaning different sheets of glass have different rates of thermal expansion and contraction, depending on how and when they were produced. The rate at which the finely ground glass in the enamel expands and contracts in temperature change, may be different or, incompatible, to the rate of expansion and contraction of the base glass. Fundamentally, an incompatible CTE between the base glass and the crushed glass within the enamel can result in improper fusion during firing. This inadequate bond makes the enamel particularly vulnerable to flaking or 'pinging' off the base glass, once again a process that is further accelerated by the presence of condensation.

Climate

The climate and environmental conditions which surround a stained glass window are not a cause in itself for paint loss, but can heavily contribute to the rate of loss if the glass paint is fragile. If paint is well fired, and well bonded to the base glass, it will last the life of the glass itself. Condensation is the main environmental factor that accelerates the deterioration of fragile paint layers, this being the reason why managing the climate is so important when fragile paint is suspected.

The UK climate is characterised by generally mild temperatures year round, with rainfall that is fairly evenly distributed throughout the year, (reaching 1000mm annually in some regions.) Conditions are frequently cloudy and damp with typically high relative humidity (often in the range of 70-90%). A combination of regular rainfall, consistent cloud cover and high winds sweeping warm, moist air across the country can lead to increased moisture in the air, which can often reduce the rate of surface moisture evaporation.

This environment combined with the often poorly ventilated, damp conditions in historic buildings, can lead to condensation gathering on the internal face of the painted glass. This water penetrates compromised glass paint through any micro-cracking in the paint layer, and as the climate changes, the constant wetting (expanding) and drying (contracting) of this moisture can result in

the gradual deterioration and corrosion of the paint, ultimately leading to its loss. Often the presence of microbial growth or dust/grime can further slow the evaporation of condensation on the glass surface, as such accumulation is often hygroscopic, meaning it absorbs and retains moisture from the surrounding air, prolonging surface wetness (see microbial growth.)

By comparison, Australia exhibits a more diverse array of climates across the country due to its size. The north experiences predominantly tropical conditions, the east largely subtropical climates, the central regions are arid, the south is temperate, and Tasmania is characterised by a cool-temperate climate. Stained glass exists all across the country, meaning there will be no one size fits all conservation recommendation when it comes to addressing climate concerns. Due to its size and the concentration of glass, the following investigations will be mainly focused on Melbourne.

The differences between England and Melbourne regarding the age of historical buildings, the differences in temperature, humidity, and levels of condensation, support the hypothesis that 19th century stained glass windows in Melbourne are at a comparatively lower risk of paint loss worsened by poor evaporation and moisture penetration. However, the Fellow cannot rule out this concept, with the impact and possible treatment options of Melbourne's climate on fragile paint more thoroughly discussed in the Environmental Protective Glazing and Environmental Monitoring section of this report.

Melbourne Paint Loss

In Melbourne, paint loss is a pervasive issue for countless imported and locally produced stained glass windows. For the purpose of this report, the Fellow will focus on researching and discussing the paint loss evidenced in windows imported from Hardman Powell and Co. specifically *The Great West Window* in St Patrick's Cathedral, and the paint loss exhibited in stained glass windows produced by locally based studio Ferguson and Urie.



Figure 7. Image one, two and three: Paint loss detail from Hardman, Powell & Co, Great West Window in St Patrick's Cathedral, Melbourne. (Photos Courtesy of Bruce Hutton, Almond Glassworks.)



Figure 8. Image four: Paint loss detail from Ferguson and Urie detail from the tracery of St Paul's Anglican Church in Latrobe Terrace Geelong, made circa 1867. (Photos Courtesy of Ray Brown.)



Figure 9. Image five and six: Paint loss detail from Ferguson and Urie detail from *All Saints Anglican in South Hobart*, made circa 1868. (Photos Courtesy of Ray Brown.)

As mentioned previously, a factor that could contribute to the cause of paint loss in Ferguson and Urie windows is the composition of the paint, how well it may have been originally mixed and the time and temperature at which the paint was fired onto the face of the glass. In conversation with Ray Brown, the Fellow was able to learn more about the operation of the Ferguson and Urie studio that may have led to faults in the manufacturing and firing of stained glass. Ray Brown accounts that it appears that the firm may have experienced a high turnover of kilnsmen who were not particularly proficient in

their trade. During the 1860s and 1870s, Ferguson and Urie were the only stained glass manufacturing business in Victoria, meaning they either had to import skilled kilnsmen from England, Ireland, or Scotland, and train them locally. This training would likely have been undertaken by stained glass artists David Relph Drape and Lamb Lyon, as James Ferguson and James Urie, being plumbers, slaters, and glaziers by trade, would have had experience with leadlights but no prior knowledge of glass firing. Such circumstances could easily have contributed to inconsistencies in firing practices and, consequently, to the deterioration seen in their painted glass today. It is the Fellow's understanding that no paint samples of any Ferguson and Urie stained glass windows have been scientifically studied to help determine the cause of deterioration.

During placement both at York Glaziers Trust and Barley studios, the Fellow had the opportunity to witness and understand more about paint loss, and discuss what treatments can be undertaken to address the issue in Melbourne.

In Conversation with Alison Gilchrist, Barley Studios

The paint loss exhibited in windows produced by Hardman and Co. has been researched thoroughly by Alison Gilchrist. Alison Gilchrist holds an MA in Stained Glass Conservation from the University of York and is an ICON accredited conservator at Barley Studios. In order to better understand the exact reasons for paint loss in Melbourne and possible treatments, the Fellow consulted Alison Gilchrist during their placement at Barley studios. The Fellow chose to predominantly discuss the *Great West Window* at St Patrick's Cathedral in Melbourne, as Alison Gilchrist had specific knowledge on Hardman and Co. including a 2010 report she wrote the subject titled "'The tears wept by our windows': severe paint loss from stained glass windows of the mid-nineteenth century', MA thesis (University of York, 2010).

This report, "Investigate(s) the phenomenon of severe paint loss from windows of the mid to late nineteenth century, commonly known as the

'borax problem'. Focussing on three case study windows made by Hardman & Co. of Birmingham and installed at, Beverley Minster, Sherborne Abbey and All Saints' Church Emscote, the study addresses historical, technical and conservation aspects of severe paint loss."¹³

To briefly summarise Alison Gilchrist's research on this subject, the **base glass** analysed from each of the three case studies were all standard compositions of soda-lime silicate, lead-lime silicate and sometimes a hybrid of the two. This is an important finding as the composition of the glass will determine the firing temperature required to achieve adequate fusion of the glass paint. Firing schedules that are incompatible with the glass composition may subsequently result in paint loss. Alison Gilchrist notes that, "the softening point of lead silicate glass is significantly less than that of soda-lime silicate glasses," elaborating that, "If all the pieces of each window were fired together, at a similar temperature, then the paint on the soda-lime silicate pieces would have been left underfired compared to that on the softer lead-silicate pieces."¹³, a concept also explained by ICON accredited conservator Nancy Georgi at York Glaziers Trust and explored in the following section of this report.

As well as these findings of the base glass composition, Alison Gilchrist also notes that, "As paint would have been attached more firmly to the softer lead silicate glasses, it is notable that the colourless glasses used for the flesh areas (which show the worst deterioration at both Sherborne and Beverly) have the harder soda-lime silicate composition,"¹³ providing further insight into any portraits or hands that are exhibiting signs of paint loss in St Patrick's Cathedral.

Regarding the **glass paint** analysed from each case study, results show that there is relatively little difference in the paints used by Hardman and Co. between each study, which is notable because the case studies analysed samples that spanned over a 40 year period.¹³

The glass paints were mostly composed of lead-silicate glasses, with metal oxide pigments

(primarily iron oxides) and sometimes cobalt in later windows.¹³

Alison Gilchrist's research also shows that the composition of the glass paint at Sherborne Abbey to be over-pigmented and relatively coarsely ground when viewed under electron microscope. Coarsely ground particles can lead to an increased risk of micro-cracking, allowing moisture to more easily penetrate fragile paint layers leading to an increased risk of paint loss. This inadequate preparation of glass paint components may also be a contributing cause for paint loss at St. Patrick's Cathedral.

Alison Gilchrist's analysis and findings regarding the West Window of Beverley Minster (1859–1865) were of particular interest to the Fellow as the stained glass windows produced in this specific case study are the closest in date to the Great West Window at St. Patrick's Cathedral in Melbourne (commissioned in the mid to late 1860s, and installed circa 1867-1868.)

In summary, Alison Gilchrist's research showed The Great West Window at Beverley Minster, was designed by John Hardman Powell in 1856, was executed in phases, with the upper tracery installed in 1859 and the lower tracery completed in 1865.¹³

A comprehensive condition survey was not undertaken at Beverly minster until 2007, when York Glaziers Trust documented significant deterioration, reporting that the glass paint was 'generally soft with much loss of the trace line across the window, giving it a ghostly appearance' where, 'structural problems (with the lead and mortar) have resulted in cracks to both the lead and glass as well as water penetration inside.'¹³ The survey also noted significant loss of painted detail in the lower section of the window, while deterioration in the upper section was described as "curiously less advanced." with the suggested reason for deterioration at the time being, "the use of non traditional fluxes (the use of borax,) incompatibility of the glass paint with the glass substrate, "over zealous cleaning" and glass corrosion." (It has long been argued that the 19th-century practice of adding a flux such as borax,

to glass paint mixtures in order to reduce firing temperatures led to significant paint loss. This phenomenon subsequently became known as the “borax problem.”)

Subsequent examination identified differences in paint colour and composition between the two tiers. The lower tier windows, with more significant paint loss, were painted with a black glass paint that contained small quantities of iron oxide combined with cobalt, chromium, manganese, nickel, copper, and zinc. In comparison, the upper tier windows, which exhibited less paint loss, were painted with a red-brown paint characterised by a high iron oxide content.¹³

Despite earlier hypotheses regarding the use of borax, analytical techniques used in this particular case study were capable of detecting boron, however no boron was detected in any paint samples, indicating that borax was unlikely to have been added as a flux in this case study.¹³ Overall, the paint compositions were largely consistent with nineteenth-century recipes, with pigment-to-flux ratios within ranges considered optimal for glass painting, and, “No obvious problem with the chemical composition of the paints which might help the explain their deterioration”¹³

Analysis of the base glass at Beverly Minster likewise revealed no significant differences between the lower and upper tiers. The composition broadly being described as soda-lime silicate, flint glass (potassium-lead silicate,) and hybrid glasses (a combination of the two). Alison Gilchrist’s report also notes that, “with exception of hybrid glasses, the compositions corresponded well with glasses of the same period at other sites and with glass-making recipes of that time”¹³

In conclusion, the Fellow believes that the research undertaken by Alison Gilchrist on the Great West Windows at Beverly Minster can help practitioners in Melbourne develop more accurate hypotheses regarding the manufacturing processes and potential causes of paint loss in the Great West Window at St Patrick’s Cathedral, Melbourne. Guided by the information in this report, the Fellow makes the following hypothesis about the Great

West Window in St Patrick’s Cathedral.

- The base glass used throughout the windows are likely to be standard compositions of soda-lime silicate, lead-lime silicate or a hybrid (combination), consistent with glasses of the same period.
- The glass paint (regardless of its tone or colour,) are also likely to be standard compositions mainly composed of low-firing lead-silicate glass with metal oxide pigments that are largely consistent with nineteenth-century recipes.
- The paint loss exhibited throughout the Great West Window in St Patrick’s Cathedral may be due to the following factors:

-The physical structure of the paint layer:

How well the paint components were ground and how coarse the paint particles are.

-Firing temperature:

As mentioned above, glass paint applied to a softer lead-lime silicate base glass and fired at a lower temperature would have adhered effectively, whereas paint applied to a harder soda-lime silicate or possible hybrid glass and fired at the same lower temperature would have poor adhesion.

-Kiln Placement:

Kiln firing techniques during this time often produced inconsistent firing results in each batch of fired glass, irrespective of their base composition. This was often caused by the kilns design, where certain areas of the kiln bed did not get to the correct temperature, leading to ‘hot’ and ‘cold’ sections of the kiln, resulting in improper adhesion of glass paint to the glass.

-Architectural environment:

Condensation on the painted face of the window would accelerate paint loss caused by either of the above two factors. Obviously a more likely factor for paint loss in Beverly Minster, but still worth investigating as a cause in St Patrick’s Cathedral.

The Fellow believes that in addition to these hypotheses regarding the glass paint, it would be advantageous to research the specific colour

of paint on the Great West Window panels at St Patrick's Cathedral. If the glass paint on the Great West Window shows to be either black, or a red-brown colour, there is a possibility that the red-brown paint used by Hardman and Co. on the upper tier of Beverly Minster windows in 1859, or the black paint used on the lower tier of windows in 1865, may be the same paint used on the Great West Window in St Patrick's Cathedral. This may provide more information as to the chemical composition of the glass paint, its stability and performance over time. The Fellow also assumes that as both samples of paint from Beverly Minster from this period were tested, and did not have any traces of boron present, it is unlikely, but not certain, that the glass paint on the Great West Window at St. Patrick's Cathedral does not have borax incorporated in the mixture as a flux, and is not the cause of the paint loss issues.

The Fellow also suggests that the reason for paint loss in Ferguson and Urie stained glass windows may also be due to a combination of some, or all of these above listed issues. With this information, the Fellow consulted Alison Gilchrist on the necessary research, documentation, and possible treatment options for these examples of paint loss in Australia.

Initial advice was to first establish when the majority of the loss occurred. It was advised to first seek out any photographic evidence from previous decades in order to compare stages of paint loss and determine whether the deterioration has progressed over time or remained relatively stable. In conversation with Alison Gilchrist, the Fellow came to understand that several Hardman and Co. windows in the UK experienced catastrophic paint failure within the first couple of years of installation, findings supported by early correspondence between the studio and churches.¹³ It is possible that the same issue may have occurred with Hardman and Co. windows imported abroad, with the paint loss having taken place relatively early in the window's history. If so, the current condition may have remained largely stable in the years since, and there may not be as strong a case for immediate and costly restoration intervention at this stage.

Secondary advice from Alison Gilchrist was once the history is established, to examine the current condition of the window. In situ investigations should be conducted to assess the present condition and type of paint loss. Assessments may be made as to whether the remaining paint on the window can withstand gentle dry or wet cleaning. To test this, a small test area may be gently cleaned in situ to evaluate the stability of the paint under minimal intervention. More information on cleaning chemicals and techniques can be found in Appendix 1. Where possible, a portable microscope may be used to closely examine and document the condition of the paint surface in detail. Alongside historical comparison, this research should seek to conclude if the remaining paint appears relatively stable yet damaged, or unstable and actively deteriorating.

According to Alison Gilchrist's experience, the rate of paint loss in Hardman and Co. windows is often inconsistent. In some cases, deterioration appears to have slowed over time, with the remaining paint now relatively stable. In contrast, other examples continue to exhibit active paint loss, indicating that deterioration is still ongoing. As mentioned above, if evidence suggests that the majority of paint loss occurred early in the window's history and the condition has since stabilised, it raises the question of whether intervention is completely necessary, notwithstanding the condition of the lead and putty and possible need for restoration of these elements. Further treatments for paint loss will be described in the following sections of this report.

In Conversation with Nancy Georgi, York Glaziers Trust

The Fellow also consulted ICON accredited conservators Nancy Georgi and Sophie Gwynn at the York Glaziers trust regarding this issue. Nancy Georgi provided equally valuable insight into the possible reason for certain sections of paint loss in the Hardman and Co. window in Melbourne.

As referenced in paragraphs above, one possible reason for paint loss is the composition of the base glass and the firing temperatures required for different glass compositions. Nancy Georgi assisted the Fellow in identifying two seemingly

identical adjacent sections of the Great West Hardman and Co. window, where one piece exhibited paint loss while the other remained intact.



Figure 10. Image one: Paint loss detail from Hardman, Powell & Co, Great West Window in St Patrick's Cathedral, Melbourne. (Photo Courtesy of Bruce Hutton, Almond Glassworks)

In conversation with Nancy Georgi, she explained that this may be an example where two similar pieces of glass next to each other, one exhibiting paint loss and the other not, may have been similar enough in colour to be chosen to sit alongside one another, but may not be from the same sheet of glass or identically chemically composed. As discussed, soda-lime-silicate composition of glass requires a higher firing temperature, whereas a softer lead-lime-silicate composition of base glass requires a lower glass paint firing temp. The example of these adjacent pieces pictured above goes to the theory that the paint loss in these windows may be caused by the composition of base glass and inaccurate firing temperature.

At present, the Fellow has not yet had the opportunity to undertake this type of in-depth research of the Hardman and Co. window at St Patrick's Cathedral or complete any Ferguson and Urie case studies, however the knowledge gained and the advice provided by members of both Barley Studios and York Glaziers Trust on this subject will inform future research opportunities

for the Fellow. Importantly, the Fellow recognises that this information is not just relevant to a single practitioner or stained glass window, but offers a framework for understanding patterns of 19th-century paint loss more broadly, with potential applications to a wider range of historic stained glass in Melbourne and Australia.

Treatments for Paint Loss

After careful research and documentation of the paint loss has been conducted, the next step is to consider all the restoration options available for the type of paint loss exhibited. In conversation and in practice with conservators at The York Glaziers Trust and Barley Studios, the Fellow was able to gain an understanding of the basic principles for treating paint loss in line with modern conservation principles cited in the CVMA. Any restoration work proposed in these (or similar) cases should begin with an understanding of the guidance outlined in section 4.3.2 of the CVMA, which states: "Paint consolidation is only recommended when paint is in imminent danger of loss. In the case of unstable, but not flaking, paint, preventive conservation methods are preferred. The refiring of stained glass is never acceptable." In this section of the report, the Fellow will elaborate on the different treatments currently available.

When faced with **powdering** paint loss, there is no current intervention that can stabilize or re-attach missing areas of corroded paint. It is not in accordance with CVMA guidelines to refire paint, or to indiscriminately apply any type of adhesive or resin over the top of a large area of historical paint to secure it. It is documented that when epoxy resins such as hxtal, araldite or acrylic resins such as paraloid B-72 are applied over a large surface area of powdering paint loss, tensile stress can cause both the resins and fragile paint to loosen and detach from the base glass.¹² Currently, the only intervention available for reducing the rate of powdering paint loss is to remove the affected panel from its original glazing and place it into a protective glazing system (see Environmental Protective Glazing). Placing the panel into protective glazing ensures the fragile paint now exists in a stable and controlled ambient

environment, therefore dramatically decreasing the constant expanding and contracting caused by condensation gathering and drying on the paint surface. This process is done only to prolong the paint, with the understanding that it is likely the paint loss will continue to occur over time, only much slower.

However, unlike powdering, there are methods to secure paint that is actively lifting off the base glass, defined as **flaking** paint loss. While the process of securing these flakes may be time consuming, it is the responsibility of the conservator to attempt to retain as much original material as possible, also making a big difference in the viewers ability to interpret the subject matter of a historical stained glass panel. The most common and effective acrylic resin for securing flaking paint loss is **Paraloid B-72**. In conversation with Sophie Gwynn at the York Glaziers Trust, the Fellow had the opportunity to learn about the properties and application of paraloid B-72, and had the chance to secure fragile paint using the materials over the course of their placement. Information on the properties and application of paraloid B-72 can be found in Appendix 2.

Cold Colour Painting

The next treatment the Fellow explored for addressing paint loss is a technique widely known as cold colour painting. This method involves the application of an oil based paint or mix of oil based medium and pigments, most often applied to the back side of the glass (granted any back painting is unaffected) to fill in specific areas of lost paint. The purpose of this intervention is not to completely repaint the missing sections, but with justification, to enhance the ability to interpret panels that have suffered significant loss of original paint. Cold colour is also often applied in thin lines over cracks that have been edge-bonded with epoxy resins or silicones.

Through their placement at both York Glaziers Trust and Barley Studios, the Fellow had the opportunity to observe cold colour being applied to historical stained glass windows using a variety of different methods. Cold colour mediums used in England

include maireri restoration colours and glass paint mixed with the oil based medium gold-size. Information on the properties and application of maireri paints and gold-size medium can be found in Appendix 6.

Plating

Plating is a practice in stained glass conservation in which a secondary piece of glass, cut to match the size and shape of the original, is placed behind and secured to the back of the historic glass, either by copperfoil tape or with the use of adhesives/resins. Plating may be useful to provide structural support when original pieces have been edge-bonded or may be used to visually adjust colour and tone. Plating is a widely accepted practice in modern conservation and serves as a reversible measure to further protect original material. More information on plating can be found in Appendix 7.

Edge Bonding

Different types of conservation adhesives have been used by studios throughout contemporary conservation history to restore and secure breaks in glass. These materials include various types of industrial glues, epoxy resins, ultra-violet acrylic resins and silicones. Scientific research into the performance of these materials is detailed in the 1999 research report "*Conservation: Materials and Methods*," published by the Corpus Vitrearum in 2000, Jägers, Römich, and Müller-Weinitsche, stating in its conclusion that investigations indicate that dual component epoxy resins are most commonly used for fixing breaks, due to their strength, long-lasting adhesive qualities, ease of application and drying time.¹² Below is an example of edge-bonding at Merchant Taylors Hall in York, where there has been significant damage to historical pieces of glass, however conservators have been able to maintain and preserve as much original material as possible.



Figure 11. Edge Bonding at Merchant Taylors Hall, York.

During their placements at both York Glaziers Trust and Barley Studios, the Fellow had the opportunity to undertake edge-bonding with several different materials. **Araldite 2020**, **hxtal**, **Silcoset 153 silicone** and **CAF 3 silicone**. Information and application information for Araldite 2020 and hxtal, can be found in Appendix 3. Information and application information for CAF 3 silicone and silicoset 153 can be found in Appendix 4.



Figure 12. Image one: Edge bonding achieved with CAF 3 silicone at Barley Studios



Figure 13. Image two: Edge bonding with Araldite 2020 at York Glaziers Trust, photo courtesy of York Glaziers Trust

There is no single adhesive, resin or silicone that will meet all criteria across every restoration project. While some are similar, each have qualities that may be advantageous or detrimental given the characteristics and condition of the glass and the environment. Only with an understanding of the advantages and limitations of each resin can the most informed decision be made about which adhesive to use.

Copper Foil

Using copper foil as an edge-bonding method is often employed in scenarios where, for example, during a past restoration of two broken pieces, the edges of each piece have been heavily grozed apart and as a result, the current state of the glass edges do not fit closely enough to achieve an adequate bond with epoxy resins or silicones. Alternatively in this scenario, one could also incorporate a thin lead line where the break runs, but if the glass cannot afford the width of the heart

of the lead to grow the piece within the design, copper foil may be the best choice, and will allow pieces to sit as close to each other as possible and be soldered together to achieve bonding.

Microbial Growth

Visible microbial growth often presents as a layer of green film growing in certain sections or across the entire face of historic stained glass. Microbial growth is hygroscopic, meaning that the growth attracts and retains moisture against the surface of the historic glass, leading directly to the loss of unstable glass paint. The Fellow came across several examples of microbial growth growing on the internal face of stained glass windows during their travels, however due to differences in climate it is less of an issue in Australia, but still can occur. Discussions on the treatment of microbial growth are in Appendix 1.

Glass Corrosion

Corrosion on glass often appears as an iridescent sheen or etched droplets on the surface of the glass. Advanced corrosion can appear as deep pits across the face of the glass (pictured below.) Corrosion is mostly evident in very old glass, and can result from repeated cycles of dampness, wetting, and drying corroding the glass. In some cases, corrosion arises due to the instability of the base glass itself. Evidence of this would be if all pieces in a stained glass window of a particular colour exhibit signs of corrosion, this is likely linked to the chemical composition of that glass type. Many of these unstable pieces may no longer exist today, as earlier restorers may have replaced them with more stable glass. Advanced corrosion as shown below is a much more common issue with unstable medieval glass, and therefore, occurs less frequently in Australia due to the age and composition of more modern glass.



Figure 14. Medieval glass corrosion at York Minster

Restoration and Conservation of the Lead matrix, solder and Putty

During the Fellow's research they developed an understanding not only of the restoration of glass and glass paint, but also of the importance of treating all the elements of a stained glass window, including the lead comes, solder, and putty, with equal care and consideration. Section 4.5 of the CVMA outlines guidelines for structural consolidation and emphasises that the same restoration principles that apply to the glass, also extend to the lead, solder, and putty. Section 4.5.2 states, "The supporting matrix of a stained glass panel may consist of comes of lead, zinc or other metal, copper foil, concrete, putty, or another material. Regardless of its date, this matrix is an integral part of the artistic design of a panel and contributes to its historic value. Conservation of the supporting matrix is an essential aim, although some intervention, including replacement, may be warranted by its state of preservation and/or the conservation needs of the glass." ⁹

Through their placement alongside the team at the York Glaziers Trust, the Fellow was able to see the degree of commitment to this section of the CVMA. Many of the historical stained glass panels being restored at York Glaziers Trust from York Minster had extensive cracking through the lead matrix, solder joins, and loss of putty. The Fellow was able to see the process of photography, documentation, discussion of methodology and restoration of such issues during their placement, and took note of how these guidelines present in practice. Firstly, as referenced in the CVMA, even if the lead matrix is not the original lead, preservation of the lead is still preferred over replacement. Even if there is relatively extensive damage to the matrix, there is almost always an effort to re-solder joins and cracks in the lead. The length of this practice has its limits however, and like all interventions must have justification. Many panels undergoing this assessment when being installed into EPG systems, where they are protected from wind, rain, and heat from the sun, (exposure to these elements is widely recognised as accelerating the deterioration of lead.) In addition to this, the size and location of a panel was also always taken into account. There may be a stronger argument for re-leading a panel if it is not being installed into an EPG system, unusually large, extremely fragile and/or has very difficult accessibility. Such exemptions from maintaining original materials can be justified from a safety perspective, but not usually an aesthetic one.

In addition to the lead matrix and solder, section 4.5.2 of the CVMA also comments on the puttying or re-puttying of a stained glass window, stating, “(Re)puttying is not always necessary or desirable and depends on the condition and future placement of the panel. When at all required, it should be done by hand in a localized manner.”

Environmental Protective Glazing (EPG).

Currently in Australia, there are many different types of glazing systems available for the protection and conservation of stained glass windows. Throughout the country it is not

uncommon for churches and historic buildings to use metal screens, polycarbonate sheets, glazing stained glass behind toughened or laminated glass or even triple glazed units where glass is sealed in between two sheets of toughened or laminated glass.

In this section of the report, the Fellow researched modern English Environmental Protective Glazing (EPG) systems to gain a comprehensive understanding of the science, design, applications, advantages, and limitations of these systems. This investigation was conducted with the aim of evaluating whether such systems could be justified or adapted for specific circumstances of stained glass conservation in Melbourne.

It was important for the Fellow to gain a detailed understanding of the manufacture and installation of these systems. As expected, the Fellow found that gaining hands-on experience in EPG production provided valuable insight into the complex details of each individual approach. Observing the implementation of these systems at both York Glaziers Trust and Barley Studios highlighted how improperly executing even small details could significantly affect a system's effectiveness if replicated in Australia. EPG systems are a large part of the work undertaken at both York Glaziers Trust and Barley studios and the Fellow had the opportunity to work alongside both teams in understanding their individual designs and participated in their manufacture of unique styles of EPG systems.

Environmental protective glazing, previously known as isothermal glazing, is a method of glazing stained glass windows in order to provide protection of glass paint against moisture damage caused by external weathering or internal condensation. However, while this is the main advantage of EPG in locations like the UK, EPG also protects and increases the lifespan of both the lead matrix and any epoxy/acrylic resins used in restoration from environmental deterioration, reduces instances of vandalism, improves the insulation of the building and allows easier access to the windows for future restoration.

It is widely accepted across England and Europe that any stained glass window that has fragile paint, paint loss, damaged lead and/or extensive use of resins like hxtal, araldite, and paraloid should be placed into an EPG system. However, there are differing opinions on the use of EPG for stained glass windows that were produced more recently, are strong, stable and present no evidence of paint loss. Some argue that there is no need to implement EPG in these circumstances, while others believe that regardless of their condition, EPG is the gold standard of installation that will ensure a windows lifespan from the moment they are installed as new pieces for centuries onwards.

The concept of protective glazing in England began approximately 140 years ago, where the main goal was to increase the insulation properties of the building. While these attempts often resulted in issues in the conservation of painted glass, current practitioners are still able to learn a lot from early systems that actually fared quite well considering, as the common belief is that often any attempt at protection resulted in stained glass being better preserved than if there were none.

There are many different types of EPG, including internally ventilated, externally ventilated, mixed and closed ventilation systems. For the purpose of this report, the Fellow will focus on the investigation of internally ventilated systems, however a description of externally ventilated, mixed and closed ventilation systems will be outlined in Appendix 5.

Internally ventilated systems are currently considered to be the most effective. To give a basic summary of this system, (while there are slight differences from studio to studio), the historic stained glass is removed from its original position in the masonry groove, transported into the studio and installed into a custom u-shape bronze manganese frame. Any restoration of the historic glass or lead matrix can be done at this time as well.

Once framed, the window is reinstalled on the interior of the building by securing the frame to the internal masonry profile, in-front of where the window was originally installed. This is achieved by screwing in copper tabs attached to the frame, into the stonework, thereby securely suspending the framed window.

To eliminate 'light-bloom' or 'halation' (light appearing around the edges of the stained glass,) strips of lead flashing are soldered to the back of the manganese frame and overlaps about 20mm onto the masonry. This lead flashing is then gently hammered into the face of the masonry to sit flush against the profile of the stone and prevent light bleeding out from behind the panel.

Next, a secondary, protective glazing panel is manufactured and installed in the original glazing groove, where the original stained glass first sat.

As part of the design, once the framed historic stained glass is installed onto the profile of the masonry, there is a ventilation gap at the top and bottom of the panel that allows internal air to circulate through the interspace between the stained glass and protective glazing.

Airflow in this gap is bi-directional depending on internal and external conditions. When the interspace air becomes warmer and more buoyant than the indoor air, the air rises, creating a partial vacuum that draws cooler air in through the bottom vent and ejects warmer air through the top. Conversely, when the interspace air is more cool and dense, usually due to colder external conditions, the air sinks, pulling air in from the top and out through the bottom. Below are images of a model of an internally ventilated system, provided by Barley Studios.



Figure 15. Internally ventilated model: note the framed historic stained glass fixed to the internal masonry, with an external protective glazing panel separated by a ventilated interspace.



Figure 17. a top down view of the internally ventilated EPG model. Including the lead upstand filled with pebbles and the lead flashing positioned out and down the external face of the masonry.



Figure 16. This close-up shows the lead flashing and copper tab fixing system used to secure the frame to the face of the masonry.

The images below exhibit examples of internally ventilated EPG systems in historic buildings across England. Image one demonstrates a side view of an internally ventilated panel, where the bottom bronze manganese frame, ventilation gap, and overlapping lead are visible.

Image two depicts the 'Pricke of Conscience' stained glass window located at All Saints North Church, York. Painted in 1410, this window was recently restored by Barley Studios. This image shows how from a front view, it is visible how in an internally ventilated system, each panel is individually framed, stacked onto one another and secured to the masonry.



Figure 18. Image one: Internally ventilated EPG system



Figure 19. Image two: Pricke Of Conscience stained Glass window at All Saints, North Street, York.

The goal of an internally ventilated EPG system is for condensation to form on the face of the protective panel, opposed to the painted face of the historic stained glass. Even though the interspace is partially enclosed, any condensation forming on the protective glazing panel should evaporate quickly, provided there is sufficient airflow to allow the moisture to dissipate into the drier indoor air. Alternatively, depending on the building conditions, the system is designed so that excess condensation can run down the face of the protective panel and collect in a lead upstand positioned at the base of the panel (pictured above and below). This trough is filled with small pebbles or glass beads to ensure it does not fill with dust and debris. This trough extends underneath the border lead of the protective panel, and flares out over the external masonry sill, so that the condensation that drips down the face of the protective panel and into the trough is channelled outside and down the face of the lead flashing where it safely evaporates into the external outside environment.



Figure 20. Lead upstand pictured in EPG system installed by Barley Studios.

Another type of internally ventilated EPG is where the original stained glass remains undisturbed in its original groove. The protective glazing panel is secured inside a frame and is installed onto the internal face of the masonry profile, again being screwed into the stone through copper tabs. Similarly to the internal system described above, a ventilation gap is left at the top and bottom of the internal panel where air can flow through the

interspace. This second method is only installed for the purpose of insulation of the building, as the design still leaves the possibility for condensation on the face of the historic glass, therefore making this method only appropriate for leadlight.



Figure 21. internally installed environmental protective glazing in-front of quarry leadlights, installed by Barley Studios.

Protective Glazing Material Options

Part of the Fellow’s research was understanding the different styles of protective glazing panels used in EPG systems. In early productions of protective glazing, it was common for the protective panel to be manufactured with diamond quarries, irrespective of the historic glass that lay behind it. Currently, there are many more options.



Figure 22. Historical stained glass environmental protective glazing with quarries on York Minster.

At York Glaziers Trust, the Fellow learned how to produce protective glazing panels that use the lead matrix of the historic window as a template, constructing the new panel with lead lines that replicate the original design.

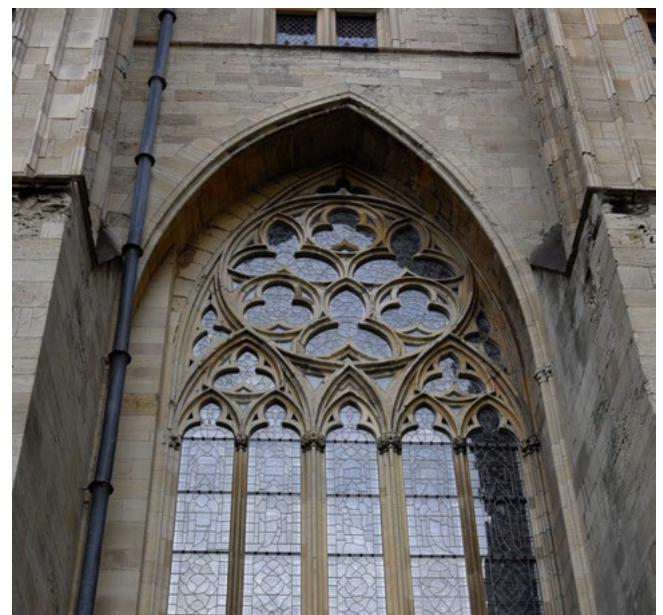


Figure 23. stained glass environmental protective glazing on York Minster by York Glaziers Trust.

Advantages of this system is that it maintains the aesthetics of a stained glass window from the outside of the building, as shown in images above. However there are some arguments against this method due to the risk of seeing double lead lines or, 'paralax' when looking up through the stained glass window. This can be reduced by careful planning and considering the distance between the stained glass and protective glazing, the height of the window and how acute of an angle the viewpoint is. It is possible to install the protective panels with these factors in mind, so the internal lead lines of the protective panel more accurately line-up with those of the internally secured historic stained glass. The type of glass that York Glaziers Trust uses for their protective panels throughout much of York Minster is Lamberts Restauero UV resistant glass, which is discussed in detail below.

In contrast, Barley Studios chooses to create kiln-formed float glass. Float glass (typically between 3–6 mm thick,) is heated in a kiln just high enough to allow the float glass to slump slightly. This subtle movement helps reduce external reflection and creates a more organic appearance compared to regular float glass. This process can also be customized to replicate crown glass, cylinder glass and drawn glass.

The Fellow came to understand that there are a variety of options available for protective panels, as mentioned above Barley Studios use their own kiln formed float, whereas other studios, like York Glaziers Trust, take advantage of the protective elements of Lamberts Restauero glass.

Lamberts glass currently produces three types of flat restoration glass titled Restauero® glass. This includes window restauero, ultra violet (UV) restauero and infrared (IR) restauero resistant glass. As well as highly reducing UV or IR rays, the glass features subtle surface distortions, scattered small bubbles, and streaks characteristic of traditional mouth-blown glass, specifically designed for the accurate restoration of historic windows and preventive conservation as protective glazing. Restauero can also be laminated, toughened, and even fabricated with acoustic insulation properties. Restauero UV and IR glass can also be fired up to glass paint

temperatures in a kiln, and not lose its thermal protection qualities.

During their visit to the Lamberts Glass factory in Germany, the Fellow had the opportunity to see the manufacture of these products, and discuss the potential applications of both UV and IR resistant Restauero glass in Australia. These products are not only used extensively in EPG systems, but they can also prove extremely beneficial as traditional glazing for historic buildings where interior contents require protection from UV and IR radiation, such as libraries and museums.

The Fellow concludes that the use of UV and IR resistant glass warrants further investigation in Australia. Certainly, in the conservation of stained glass, but also in a more broad heritage context, given the high levels of UV and IR exposure from the Australian sun. The properties of this glass offer substantial opportunities for insulation, the protection of heritage buildings, and the control of environmental factors.

In addition to this, EPG assists in protecting the stained glass from vandalism, which the Fellow has also noted as a pervasive issue in Australia. EPG designed to reduce instances of vandalism can be delivered either through laminated protective panels or with the addition of conventional wire screens. Which option is chosen depends on several site-specific factors. First being the aesthetic of the painted glass that is being protected. Laminated panels are generally preferred where the stained glass painting is light in tone or minimally painted, as wire screens would be more visually intrusive in such conditions. The location of the church is also a key consideration. Buildings that may be situated away from public view, wire screens may be acceptable, whereas high-profile churches in prominent settings typically benefit from the more discreet appearance of clear laminated protective panels. Additionally, if existing screens already exist for mechanical protection, their retention is often the most cost-effective approach when compared to the installation of laminated protective panels and especially in place of the use of toughened Lamberts restoration glass.



Figure 24. Detail of powder coated protective screens over environmental protective glazing at All Saints North Street, York. Environmental protective glazing by Barley Studios.

EPG Limitations

Recognising the advantages of EPG in stained glass conservation, it is equally important to acknowledge and address its potential disadvantages, including aesthetics, financial cost and the impact on the building's existing fabric.

The aesthetics of EPG systems are widely debated across England and Europe. The Fellow had the opportunity to discuss the aesthetic impact of EPG on historical buildings with several practitioners and architects across the country. There is no doubt that the process of installing modern EPG systems can greatly affect both the interior and exterior appearance of the building, however it has been widely accepted throughout England and Europe that in circumstances where EPG is justified, the

conservation benefits outweigh the aesthetic cost, tying into contemporary conservation principles that conservation is always preferred to restoration.

However, there are some ways to mitigate the aesthetic impact of an EPG system on a historical building. These include elements like replicated lead-lines or kiln-distorted float glass opposed to flat, laminated or float glass (as mentioned above.) In Melbourne, many churches and buildings with historically significant stained glass already have external metal screens fitted. From an external perspective, if EPG was to be proposed for any of these stained glass windows, the aesthetics of the protective glazing would be almost indiscernible behind the metal screen, as they were in All Saints North Street, York, pictured above. There is also an argument that either the replicated leadlines or distorted float glass used in the protective panel of an EPG system would actually improve the outside aesthetics of a building when compared to metal screens. However, such aesthetic arguments are inherently subjective, and it is the responsibility of the practitioner, heritage architects, and client to discuss consider these factors in order to arrive at a solution that satisfies both the conservation and aesthetic requirements of the building.

From an internal perspective, even a well designed EPG system still does change the aesthetics inside a building. However the systems discussed in this report have been specifically designed to be the least visually obtrusive, with only about 15-20mm of lead flashing, framing and small copper tabs/screws visible up the sides of the window. The Fellow did not find that the modern EPG systems they saw using either kiln-formed glass or replicated lead matrix's to be particularly obtrusive, distracting or offensive to the overall internal or external aesthetics of the building or windows. While EPG can alter the visual appearance of historic buildings, its careful implementation can preserve stained glass without greatly compromising aesthetics. It is the responsibility of the practitioners and architects to understand these limitations, mitigate where possible and find compromise that satisfies the goals of restoration and aesthetics deemed important to all parties.

The financial cost of EPG systems must also be addressed. The removal of historic stained glass, the custom fabrication of an EPG system, and its reinstallation can present a major financial commitment for the client, sometimes in addition to the cost of environmental monitoring (as discussed below.) There is no denying that small parish churches and historic buildings often lack the resources or funding to undertake such endeavours. This is true in Australia, England, and around the world. While some minor adjustments can be made to mitigate costs, EPG is not always going to be an option, and in these cases less interventive conservation practices and methods will often take the place of larger works.

Each heritage project is different, and for some of the larger, more well-resourced heritage buildings and stained glass windows, the Fellow would argue that while there is no denying that EPG does have significant costs up front, it is an investment for the preservation of these historically significant pieces. If it is shown that a building's environment is accelerating the deterioration of its windows, installing an EPG system can reduce long-term future restoration costs by mitigating environmental impacts on the glass and glass paint, extending the life of the putty and lead by protecting it from weathering, reducing the need for re-leading, and improving accessibility for future works. Not to mention the historical cost of potentially losing, within the next 100 or 200 years, the ability to read and interpret the design of some of Australia's oldest and most valuable stained glass windows.

Finally the Fellow notes the impact on the existing fabric of the building. Throughout Australia, there is a belief that the process of installing EPG damages the surrounding stonework and unduly compromises the existing material of the building, putting the needs of the glass ahead of other elements in the architecture. Aspects of the architecture, like the masonry, need to be considered and respected at every stage of intervention. It is also often the case that the condition of the stonework is assessed by engineers in these early stages in order to gain approval of the proposed installation method, and

to ensure that the masonry is in suitable condition to support the system.

However, in modern examples of internally ventilated EPG observed by the Fellow, the only alteration to the masonry involved the use of small screws drilled into the stonework through copper tabs, (typically installed at 300 mm intervals up the window - with closer spacing required for wider windows), used to secure the framed stained glass to the internal masonry profile. This level of intervention is widely accepted throughout England and Europe in buildings from the medieval period through to the 19th and 20th centuries.

The Fellow believes that this level of intervention is currently, equally accepted throughout Australia. Wire screens are still commonly installed externally over stained glass across the country for protection against vandalism. These screens are often secured using a similar installation method, involving the drilling of small holes and the insertion of screws into the masonry to secure the screens via wire tabs. The only distinction (notwithstanding the weight of the screens) between these processes is that one is external and the other internal; however, the impact of drilling small holes into the masonry is effectively the same. The Fellow believes that a well designed and considered EPG system should not damage or adversely impact the other elements of the building, like the masonry.

Environmental Monitoring

At the outset of every restoration project, comprehensive planning is essential to establish a clear understanding of the possible risks, limitations, and considerations, with research often necessary to justify the cost of intervention. It is not uncommon at this stage that some degree of environmental monitoring of the internal and external environment is undertaken, especially when requested by the client for further evidence of any deterioration. Environmental monitoring systems are relatively simple, however the compilation and interpretation of data can be a costly and complicated process, often completed by professionals who dedicate their profession to

this task. The Fellow investigated this process with assistance from Nancy Georgi at the York Glaziers Trust, and has come to understand the basic principles of environmental monitoring.

Environmental monitoring is the process of monitoring and recording climate data in both the internal and external environment of a building. There are different methods to monitor climate, however it is recommended that equipment used should test ambient inside temperature, outside temperature, relative humidity, and the surface temperature of the glass. Dew point can also be calculated from the interpretation of this data, allowing practitioners to understand the frequency of when condensation physically occurs on the surface of the painted glass. These readings can be recorded through different types of devices, usually developed for museums and galleries. Ideally, these devices should be monitoring two or more elements within a building, for example the north and south sides of the building or an EPG protected window and a single glazed, unprotected window. Testing equipment should be configured to take measurements at approximately 15-minute intervals, allowing for the accurate capture of rapid temperature fluctuations, ensuring the collection of reliable data. At a minimum, there should be an aim to conduct 1 year of environmental monitoring, but best practice would attempt for 2 years, to reduce outlier readings from especially warm, dry or wet seasons.

It is also recommended that the chosen monitoring system should automatically log and upload data, allowing for easy access, download, and analysis. To avoid data loss and ensure continuous oversight, data should not be left until the end of the year to be retrieved; instead, it should be downloaded and reviewed on a monthly or quarterly basis.

At this point in time, the Fellow is unaware of any successful environmental monitoring attempts in Australia. However it would be highly beneficial to the conservation community to undertake environmental monitoring in Melbourne, ideally in select historic buildings with stained glass windows

that have known condensation issues, signs of significant deterioration, fragile paint or enamel loss.

This monitoring would not only generate valuable data on the specific environmental conditions and frequency of condensation affecting the glass surfaces, but also provide insight into the surface temperature ranges experienced by stained glass windows. The Fellow is especially interested in this last point, and believes it warrants closer consideration in the Australian context, where higher summer temperatures may pose different or greater risks to stained glass than those typically encountered in England.

However, environmental monitoring is site specific, and is usually required to be conducted at each separate site before justification for intervention can be argued. While collecting environmental data from a single historic church or building will obviously not provide a complete overview of the condition of all stained glass windows in Australia, such data arms both practitioners and architects with more information to understand the extent to which environmental factors may, or may not, be contributing to the deterioration of stained glass in different areas of the country.

Recommendations

In order of reporting, the Fellow makes the following recommendations for the continued development and preservation of stained glass in Melbourne and Australia.

Corpus Vitrearum

The Fellow recommends that alongside the Burra Charter, the Corpus Vitrearum guidelines be more widely disseminated, recognised and applied.

While the ICOMOS Burra Charter is still relevant for Australian heritage projects involving glass, the Corpus Vitrearum has much more specific information to offer both current practitioners and students or apprentices entering the industry.

The guidelines not only provide clear and concise advice on best-practice methods for traditional

stained glass restoration, but also apply broadly to all forms of glass. As stated in Section 1.4, "For the purpose of this document, the term 'stained glass' covers painted and/or stained glass as well as plain leaded lights, copper-foiled glass, dalle de verre, and other types of architectural glass, whether in situ or after removal to a museum or private collection."

The CVMA therefore advocates for the same high standards and principles in the restoration of all glass, making it a highly relevant document for the wider Australian glass community.

It is also the Fellow's recommendation that international CVMA membership be considered. CVMA membership offers members a network of stained glass professionals, seminars, and an extremely valuable catalog of resources and scientific and academic reports that are useful for Australian practitioners undertaking this type of work.

Accreditation

At this time, the concept of developing a type of accreditation system like ICON accreditation would prove difficult in Australia. ICON does not singularly serve to accredit stained glass practitioners but has long been established to accredit a wide range of conservation and restoration professionals from all fields. There are a multitude of complex factors to consider before the prospect of accreditation for glass practitioners may be considered in Australia. This includes the question of if accreditation would be issued and recognised nationally? Or state by state? Considering the present structure of heritage directory services, the question of what the process of accreditation would look like and who would govern such a system, accreditation appears to remain a significant challenge.

In place of an Australian-specific accreditation system, the Fellow encourages more Australian practitioners to seek ICON international accreditation. Accreditation with ICON could play a vital role in more clearly identifying highly experienced and accomplished practitioners qualified to consult on and undertake heritage restoration. It would also enhance the ability of

private clients and heritage architects to locate and compare suitably qualified professionals for heritage and restoration projects. Accreditation also may foster greater professional community, strengthen connections between studios and independent practitioners, and ultimately contribute to a higher standard of work nationwide. The Fellow hopes to seek ICON accreditation in the future and encourages other practitioners to do so as well.

Education and Pathways

The Fellow believes several lessons can be learnt from the educational opportunities available to glass practitioners throughout England.

Firstly, the Fellow recommends strengthening ties between traditional stained glass studios and tertiary education courses. The Fellow suggests that in order for traditional tradespeople to enter into the industry and be more adequately equipped with the information they need to undertake restoration projects, more on-the-job training opportunities could be presented to those who have completed these courses. This was evidenced by students in the MA in Stained Glass Conservation from the University of York, who, while the Fellow was on placement with York Glaziers Trust, were completing a 12 week placement program at the York Glaziers Trust as a final part of their studies. It was clear that the placement gave students an understanding of the operations of a traditional studio, as well as an opportunity to gain fundamental, hands-on experience in various different types of restoration projects and scenarios, further preparing them for future work in the field.

While further education in glass in both England and Australia is comprehensive and supportive, certain aspects of professional practice such as site work, installation, project management, teamwork, customer service, and problem-solving, are skills that can only be fully developed and refined within a workplace environment. In addition to this, it is crucial that traditional glass-painting skills used in the restoration of stained glass be passed on, as these techniques face the real possibility of being lost in Australia without intentional mentorship.

However, in lieu of the same type of government support and investment from heritage organisations in England, in Australia it is currently the ongoing responsibility of established studios and experienced practitioners to train individuals entering the industry and help meet this need. The Fellow acknowledges the practitioners already embracing this approach and encourages others across Australia to do the same. The industry is in a position to act without waiting for the introduction of formal apprenticeship programs if there is an ongoing willingness for studios to take on graduates for work experience and employment. The Fellow emphasises that if it were not for the highly skilled and accomplished mastercrafts people that took them on in the formative years of their career, they would not have had the opportunity to achieve their current level of professional development.

The Fellow also encourages any individual who is currently studying, working or interested in the preservation of Australian stained glass, to undertake their own international travel and training experience. This type of endeavour could be undertaken through a similar fellowship program offered by the International Specialised Skills Institute, or through other various grants offered by federal, state or local government, or self funded (depending on the situation or limitations of the individual.) The knowledge and experience gained through such a program is considered priceless personally, professionally and sector wide.

The reason it is so valuable to gain experience internationally is that the greater scale and scope of projects abroad provides more opportunities to engage with unique and complex work. Additionally, the larger size of international studios and teams allows for training across a wide range of equipment and techniques, as well as the opportunity to collaborate with specialists in specific areas of the industry that may be of interest to the individual. This type of professional endeavour also encourages international partnerships with studios abroad. This would be a great chance to continue engaging in two-way conversation about current projects and

conservation practices as the Fellow intends to do with both the York Glaziers Trust and Barley Studios. In addition to this, continued international visitation and training will ensure Australian studios are up to date and well informed about current European best practice and new advancements in conservation technology into the future.

Environmental Protective Glazing

As previously discussed, Environmental Protective Glazing was a key focus in the Fellow's research and investigation. The aim of this research was to understand the different types of EPG systems, and determine if any of those systems may be beneficial in the conservation of stained glass windows in Australia.

The Fellow succeeded in this first endeavour, having spent an extended period in studios with expert teams, gaining hands-on experience in the science, production, implementation, and maintenance of EPG systems across England. Previous to this experience, the Fellow had very little understanding of this conservation tool, but now fully comprehends all the different types of EPG systems.

Without more investigation into the internal and external environments that exist within different types of Australian historical buildings, the Fellow cannot definitively advocate for or against implementing EPG for any particular stained glass windows in Melbourne, however does believe that there may be specific candidates for this intervention once researched.

If hypothetically, there is proven to be frequent condensation gathering on the face of historically significant 19th century stained glass, the Fellow believes that EPG must be considered in order to reduce the rate of paint loss in these windows. For example, The Hardman and Co. Great West Window in St Patrick's Cathedral, although exhibiting some areas of paint loss, is in significantly better condition than many 19th century Hardman and Co. windows throughout England produced around the same period. This provides Australia a valuable opportunity to conserve examples of stained glass in this

quality condition from Hardman and Co. If it was proved that condensation was accelerating the fragile paint deterioration on these windows, it is the responsibility of the stained glass community that all conservation avenues, including EPG, be considered. If justified, the benefits of removing the historic stained glass from its original glazing and installing it within a protective glazing system would have a substantial positive impact on slowing the deterioration of the fragile paint layers. As some of the earliest examples of stained glass in Australia, it is the Fellow's opinion that these conservation advantages may outweigh the associated costs and the aesthetic implications for the building.

As mentioned above, the Fellow recommends that before any EPG is considered environmental monitoring of both the internal and external conditions of the building be undertaken if internal conditions are suspected to be contributing to the deterioration of already fragile paint. This monitoring would help investigate these factors and provide a clear justification for any proposed interventions to all relevant parties.

Understanding that environmental monitoring comes at a cost, the Fellow intends to continue this research in Melbourne, hoping that if given the opportunity there is a possibility to receive funding through a grant or financial support for further research. This research may involve learning how to and undertake environmental monitoring themselves, or engaging other professionals either in Australia or abroad who specialize in this process to oversee this endeavour. The results will allow the industry to compare temperature, humidity and condensation to that in parts of the UK and Europe, in order to draw more definitive conclusions on the effects of climate on Australia's historical stained glass.

While the Fellow understands that much of this research may be difficult to apply immediately in Australia, given the need for further research, monitoring and investigation, they hope that in the future there is an interest from heritage architects, builders, conservators and practitioners, that this report can provide both insight and

groundwork, and act as an introductory perspective on how EPG systems may be considered in Melbourne and throughout Australia.

05

Personal, Professional and Sectoral Impact

In this section, the Fellow reflects on their own experience, and highlights the positive effect that the Mason Family Trust fellowship has had on them personally, professionally and sectorally.

The Fellow believes that the biggest impact to their **personal** growth through this fellowship is the confidence they gained from forming relationships and connecting with their international peers in glass restoration and conservation. The Fellow attributes this boost in personal development to the fact that they were able to spend an extended period of time in studio placement, where they were not only able to build professional networks, but also form meaningful personal connections with many of the people they were fortunate to work alongside. In addition to this, it was especially enriching for the Fellow to meet so many women working in traditional stained glass restoration and glass painting. Women made up the majority of employees the Fellow worked alongside, in positions similar to themselves all the way up to higher positions as directors. Hearing about the journeys of these women, not dissimilar to their own, and gaining valuable professional and interpersonal advice was deeply encouraging, empowering and inspiring for the Fellow.

The opportunities provided over the course of the fellowship also lead to significant **professional** growth for the Fellow. Specifically, the restoration knowledge and skills gained in areas such as

paint loss treatment, edge-bonding, environmental protective glazing, and 19th-century painting techniques have equipped the Fellow with both the technical understanding and practical experience needed to restore Australian stained glass to best standards currently available.

The Fellow has already had the opportunity to apply these skills following their fellowship travels through their work at Almond Glassworks. Specifically, as a result of their newly acquired knowledge and skills, the Fellow has been able to take on a more active role in the conservation of stained glass in Melbourne. Where previously the Fellow's involvement focused on the practical aspects of restoration, including cleaning and re-leading, they are now actively contributing professional expertise through contributing to condition reports, assisting in the development of restoration methodologies, and are involved with the long-term conservation planning for heritage projects around Melbourne.

The Fellow has also had the opportunity to apply newly acquired techniques in practice at their workplace, Almond Glassworks, including undertaking cold colour work, plating, and edge-bonding using materials and methods learned in England. These skills and insights have subsequently been shared with other employees at Almond Glassworks, transferring knowledge to the whole team across these specialist areas.

In addition to this, through attending events such as the British Society of Master Glass Painters 2025 conference, the Fellow was able to network and form professional relationships with stained glass studios from all across the UK, including practitioners and academics from Holy Wells Glass, Swansea College of Art and stained glass historian Peter Cormack. The Fellow also had the opportunity to present at the British Society of Master Glass Painters conference, delivering a presentation both on the fellowship and their work in Australia to a broad audience of English practitioners. Through this presentation, the connections between the Fellow and the English stained glass community were strengthened, resulting in a deeper understanding among UK stained glass practitioners of the professional landscape and challenges faced in Australia. The Fellow looks forward to maintaining these relationships and visiting again in the future.

Sectorally, the Fellow hopes to take all the knowledge, skills and techniques they have acquired and disseminate these teachings through a series of lectures, workshops and interviews to ensure the knowledge benefits both active practitioners and current students in glass education courses. This will include a lecture style presentation at Melbourne Polytechnic on the fellowship findings, exploring how these insights can be meaningfully integrated into practice for the benefit of the 2026 Certificate 3 Glass and Glazing and Diploma of Visual Arts - Glasswork cohorts. This presentation will be followed by a series of workshops with both course cohorts in the studio at Melbourne Polytechnic, demonstrating and disseminating the practical skills learnt in restoration to the students during the course of their study. This presentation and workshops are set to take place in early 2026, however following discussions with Donna Kennedy, it is anticipated by both the Fellow and the course that this presentation will continue as an annual presentation for both programs into the future.

In addition to the contributions to the glass community, the Fellow hopes that their research and fellowship experiences also benefit and inspire a wider audience. Specifically, the Fellow is hopeful that their insights into improving traditional trades pathways and support structures will help influence practitioners of all traditional trades to seek further education in their field, as well as continue to mentor those entering into their sector.

In November 2025, the Fellow had the opportunity to present their findings to the Australian Artisans Guild. The Australian Artisans guild is composed of traditional tradespeople and master craftspeople practising throughout Victoria and Australia. The Fellow presented on their fellowship experiences, as well as their findings relating to potential improvements in the field of Australian stained glass conservation. In addition to disseminating these findings, this platform enabled the Fellow to advocate for established members of the Guild to take on younger apprentices, strengthening the future of stained glass and supporting the sustainability of traditional trades more broadly.

The Fellow also presented at the Colour Society conference in October 2025. This shorter presentation focused on the fellowship experience and highlighted the power of colour in both historical and contemporary stained glass, as well as the opportunities the fellowship provided to build stronger professional connections in glass practice between England and Australia.

At the time of publishing, the Fellow looks forward to sending this report not only to glass practitioners, but to heritage communities across Australia, including the National Trust, and Heritage Victoria, New South Wales, Queensland, Tasmania, Western Australia, South Australia and the Northern Territory, and looks forward to collaborating with any of these parties who wish to engage further with the findings in this report.

06

Conclusion

At the commencement of this report, Rebecca Boehme posed the question: *What does the future of stained glass in Australia look like?*

After undertaking this research and learning from leading practitioners abroad, Rebecca envisions a future built on collaboration, shared knowledge, and a continued respect for traditional craftsmanship balanced with innovation and education.

Rebecca hopes for a future where stained glass conservation and restoration in Australia are strengthened through research-led practice, professional development, passion and respect within the community.

Rebecca hopes that the investigations and recommendations presented in this report will not only provide insights to the next generation of practitioners, but also inspire all members working within different areas of the glass community and broader traditional trades to advocate for a future capable of preserving Australia's stained glass heritage while embracing new ideas, techniques, and possibilities for the years to come.

07

Appendix

Appendix 1: Cleaning and Microbial Growth information and Treatment.

Cleaning:

- For the cleaning of painted surfaces, either a 50:50 mixture of ethanol and deionised water can be used, or only deionised water with basic cotton balls or swabs in an act of 'rolling' across the face of the glass, not rubbing or swiping (especially if the paint is fragile.)
- When cleaning painted glass, there is ongoing discussion regarding the use of deionised water alone versus a 50:50 mixture of ethanol and deionised water. The argument in favour of the 50:50 solution is that the addition of ethanol accelerates the drying process, thereby reducing the amount of time the painted face remains damp and potentially vulnerable to damage. However, proponents of using only deionised water argue that introducing ethanol effectively adds a solvent to the cleaning process, which could pose a risk when working with chemically unstable paint layers. Using deionised water alone avoids this risk, as it does not introduce any new substances to the glass surface that were not already present in its conservation environment.
- Smoke Sponge (a material composed of vulcanised rubber and small amounts of soap) can be used secondary to cotton balls/swabs for removing smears across the glass.

Microbial Growth:

Treatment of Microbial Growth:

- Ratio: Prepare a solution of 70% ethanol and 30% deionised water. Higher concentrations evaporate too quickly to be effective while lower concentrations lack sufficient strength to kill microbial growth.
- Spray the affected area thoroughly and leave for exactly 24 hours.
- After 24 hours, spray the area again with the same solution.
- Microbial Growth may turn brown once being killed.
- The area can now be cleaned with the standard process detailed in the above section.

Appendix 2: Paraloid information and application

Paraloid B-72 is an acrylic resin classified as a thermoplastic adhesive. It is commonly used in stained glass conservation for securing loose or flaking paint to glass surfaces. Acrylic resins like paraloid are less suitable for edge bonding when compared to epoxy resins such as hxtal and Araldite 2020 due to the differences in adhesive strength and durability.¹²

In line with section 4.4.1 of the CV, that any medium used in the restoration of stained glass must be "guided by the principles of minimal intervention and reversibility."⁹ Paraloid is

reversible. Acetone is the most commonly used solvent but alternatives such as ethyl acetate, toluene, a mixture of ethyl ketone and ethanol, or a blend of toluene and white spirit may also be used, though alcohol should be avoided. As the resin is particularly prone to deterioration when exposed to water or condensation, paraloid B-72 often naturally degrades over time and reversal is seldom required. This exposure to moisture accelerates the deterioration of the resin, ultimately compromising its effectiveness, meaning the long-term success of such a treatment can only be assured if the window is subsequently housed within a protective glazing system or maintained under controlled conditions.¹² The process to secure flaking paint with the use of paraloid B-72 is listed below.

Preparation:

- Paraloid is supplied in small pebbles that dissolve in acetone.
- Ratio: Combine 5% Paraloid with 95% acetone (other solvent options provided in section Treatments for Paint Loss).
- The reason for this ratio is that lower concentrations of Paraloid disperse more easily into the paint outlines.
- Although low concentrations have less adhesive strength, this can be remedied by repeated application.

Application:

- Use a fine paintbrush to 'float' the Paraloid solution between the unstable paint flakes and the glass by gently touching the tip of the Paraloid-filled brush to the edge of the unstable paint flake. The solution should be drawn underneath the flake and adhere the underside of the flake to the glass.
- Apply the Paraloid solution only beneath the unstable flakes, avoiding any application on top of the paint and strictly refraining from covering larger surface areas, as previously noted in the report.
- Apply three coats in total. Ensure each coat is applied only after the previous layer has fully dried, this allows the solution to 'float' into the entire area effectively.

- The solution will re-adhere the paint or enamel to the glass surface. However, this consolidation is not permanent and will deteriorate over time when exposed to condensation. If the paint is already flaking, the process is essentially a choice between losing it now or losing it later.

Appendix 3: HXTAL and Araldite information and application

Araldite 2020

Araldite 2020 is a dual component epoxy resin classified as a duroplastic adhesive.

Araldite has a thicker viscosity and dries significantly weaker than hxtal, which can be advantageous in some circumstances, for example when edge-bond repairs have no choice but to be made in situ, its drying time and viscosity means it will be less likely to lead into the leads. As it does not cure as hard as hxtal, Araldite is often preferred for use with thin or delicate glass, where harder adhesives such as hxtal could potentially introduce stress to the base glass and lead to secondary cracking or delamination. As use of araldite continues there are some concerns with the epoxy resin, including how quickly it may discolour, and the rate at which it becomes brittle, sometimes 30 years. Araldite is reversible, but with limitations. Excess resin can be removed with acetone before it has set, while dichloromethane (DCM) may also be used for removal once hardened. It must be noted that DCM is extremely toxic and must be handled with appropriate safety precautions.

Hxtal

Hxtal is a two-part epoxy resin classified as a duroplastic adhesive and is considered the strongest adhesive used for edge bonding. Hxtal is used more commonly for edge bonding when the glass pieces are able to be extracted from the lead matrix, which is preferable to edge-bonding in situ with araldite. Current best practice recommendations are to use hxtal as the epoxy resin of choice except when you have to bond in situ. Hxtal rarely yellows over time and exhibits

a refractive index very close to that of glass, making repairs less visible. Similar to Araldite, hxtal is technically reversible with excess being removed with acetone before curing, however, as with araldite, once set it can only be dissolved with dichloromethane (DCM), again a highly toxic solvent requiring extreme caution.

When mixing the components of araldite and hxtal, it is recommended never to mix less than 1gm, as possible inaccuracies that occur when measuring small amounts on a scale can have a greater effect on a smaller mix rather than a larger one. When mixing these solvents together, ensure the lid of each component is kept on, as the solvents may evaporate and cause changes in the concentration of each component, possibly impacting the result.

As mentioned in previous sections, despite its strength and stability, both hxtal and araldite are unsuitable for paint consolidation due to its difficulty of reversal and the risks associated with DCM. Additionally, because it forms a strong bond with the paint layer, there is a greater likelihood that any future detachment due to tensile stress could result in the loss of original material.

The Fellow came to understand that even given the advantageous qualities of hxtal and araldite, if either of these epoxy resins are used for edge bonding, that it is best practice to also secure a plate to the back of the original piece. This is to increase strength and durability, especially if there are 'floating' pieces which are internal broken pieces that do not border the edge of the glass.

Araldite and Hxtal are preferred for edge-bonding over silicone and copper foil methods when there are multiple or small complex cracks across a piece of glass. They allow a network of small fragments to be positioned with greater accuracy before the epoxy is applied, and produce a less visually intrusive result, as tightly aligned cracks avoid the darker lines that copper foil can create.

Preparation:

- Ratio Araldite: For a 1 g total mixture, combine 0.77 g resin with 0.23 g hardener.
- Ratio HXTAL: For a 1 g total mixture, combine

0.75 g resin with 0.25 g hardener.

- Use a small mixing pot for combining the two components. Handle each component with opposite ends of the dropper or use separate droppers to prevent cross-contamination.
- Never mix less than 1 g of Hxtal/Araldite, as even minor inaccuracies in weighing can have a greater proportional effect on smaller quantities, compromising the chemical balance and performance of the adhesive.
- Stir the components very slowly and evenly for approximately 5 minutes.
- Slow mixing helps to minimise air bubble formation, which can otherwise be drawn into the glass break during application.
- Resting period: Allow the mixture to stand for 15 minutes before use. This resting period enables microbubbles to dissipate, producing a clearer and more stable adhesive.
- Handling solvents: When mixing or preparing solvents, ensure the lid remains tightly sealed whenever possible. As solvents evaporate, their concentration and composition change, which can adversely affect the consistency, effectiveness, and predictability of the material.

Application:

- Clean the edges of the crack with a 50/50 ethanol or deionised water solution and use a scalpel to remove any debris adhering to the edges.
- De-grease the glass edge with acetone.
- Position the glass pieces so they fit together as accurately as possible, aligning any painting, shells, or feathers along the glass edges.
- Use small tabs of tape to join either side of the break line on the back of the piece, and burnish the tape using a small skewer to ensure tape is completely adhered.
- Lay a full strip of tape over the entire break, covering small tape tabs as well.
- Burnish the full strip thoroughly, paying close attention to removing air bubbles around the edges of the tabs and along the break line.
- Dip the scalpel blade into the mixture, apply a

bead of Araldite/hxtal by touching the tip of the blade to the break. The adhesive should flow off the blade onto the glass and be drawn into the crack. Only reapply if the crack remains visible or continue to apply this way until the break is fully flooded and will no longer absorb adhesive. If material is missing along the break line, create a small pool of adhesive to fill the gap.

- After 30–45 minutes drying time, clean the surface by rolling a slightly damp (not soaking) acetone cotton bud over each adhesive drop once, to avoid smearing uncured adhesive. Continue with fresh acetone buds until all residue is removed.
- Keep the mixing pot nearby and monitor drying time by poking with a skewer over the next 24 hours to test when it has fully hardened; this indicates that the edge bond on the glass has also set.
- For Hxtal: Use the same technique, but allow significantly more time before cleaning. For example, if HXTAL is to be applied in the morning, clean at the end of day. Or if applied at the end of the day, clean the next morning.
- Once Hxtal becomes tacky, clean it with acetone in the same manner as above. It can also be “pinged” off with a scalpel if no paint lies beneath. Once fully hardened, it can only be removed with the aid of DCM (dichloromethane.)

Appendix 4: CAF 3 and Silcoset 153 information and application

Silicone : Silcoset 153, CAF 3

CAF 3, CAF 33 and silcoset 153 are all single-component silicone adhesives commonly used for edge bonding in English stained glass restoration. Advantages of using silicones for edge-bonding over epoxy resins include the fact that silicones are quick drying, easy to apply, durable and is resistant to weathering and condensation, meaning it is not necessary for the edge bonded glass piece to be plated or incorporated into a protective glazing system. Disadvantages of using silicone include

that some types/brands of silicone may cloud over time, and due to silicones high viscosity, it isn't sufficiently fluid to penetrate tight breaks, meaning if there are many small broken pieces to be edge-bonded, using silicone to adhere small sections may be difficult to set and cause the original size of the piece to grow. There is an argument that the use of silicones is not inline with contemporary conservation practice as it is not able to be reversed with the use of solvents once it has cured, however many argue that reversibility is still achievable if necessary by mechanical means. This may involve using a scalpel to carefully cut away the cured silicone to dismantle previous edge-bonded areas. Those in favour of this practice note that it is actually more advantageous from both a restoration and safety perspective to be able to reverse the use of silicone through mechanical means, as it does not introduce any new chemicals to the surface of the glass (especially if there is fragile paint) and it reduces any possible use of dangerous solvents like DCM. Keeping these arguments in mind, while it is still important to consider guidelines set out by the CVMA, in practice, successful edge bonds rarely require reversal regardless of the adhesive chosen.

CAF 3 is a softer, more flexible silicone, and an acid-cure sealant, meaning that when exposed to air, it undergoes a chemical reaction that temporarily produces acidity before neutralising after fully curing. This reaction accelerates setting and enhances bond strength. A related neutral-cure variant, CAF 33, which is a more stiff and rigid silicone, is available but is unsuitable for any in situ work, as its acidic curing phase can corrode lead, although silicone would not ordinarily be used for in situ work due to its viscosity, this limitation is nonetheless relevant to note.

Application Method one:

- Preparation: Clean the glass edges with a scalpel to remove any debris then de-grease thoroughly with acetone to ensure a clean bonding surface.
- Application: tape tabs only on one side of the glass to help maintain alignment.

- Gently open the crack along the taped edge.
- Insert Silicoset 153 or CAF 3 into the break using a disposable blade, pushing the silicone carefully into the joint.
- Close the crack and allow to cure
- Cleaning:
 - Clean immediately after application.
 - First, remove excess silicone with a disposable blade.
 - Follow with a dried-out acetone-dampened cotton bud to remove any remaining residue without spreading the material.
- Curing:
 - Allow approximately 20 minutes to dry (time may vary depending on environmental conditions and layer thickness).
 - If silicone has cured, use the tip of a scalpel to very carefully run along each side of the break and remove any excess silicone.

Application Method two:

- Preparation: Clean the glass edges with a glass brush or scalpel to remove debris then de-grease thoroughly with acetone to ensure a clean bonding surface.
- Application: Load Silicoset 153 or CAF 3 into a small silicone gun, if possible one with a very small applicator nozzle.
- Apply a continuous bead of silicone along one edge of the broken glass.
- Align and press the glass pieces together, ensuring that all painting, shells or feathers are perfectly aligned and there are no air bubbles with both sides fully bonded.
- Use small binder clips to clamp at each end of the break to ensure pieces remain aligned and level whilst curing, (use small tape tabs or some sort of separation material between the surface of the glass and binder clip for protection.)
- Curing: Allow approximately 15 minutes for touch-dry and overnight for full cure.

- Cleaning: Once the silicone has cured, use the tip of a scalpel to carefully run along each side of the break and remove any excess silicone.

Appendix 5: Environmental Protective Glazing descriptions and design.

Externally ventilated systems operate under the same concept, air is free to flow throughout an interspace, however instead of removing the historic glass from the original groove, the stained glass remains in its original position and a protective glazing panel is placed in a u-shaped frame, and attached to the outside masonry, again with a gap at the top and the bottom of the protective panel. This results in air being circulated externally, moving from outside of the building, through the interspace between the stained glass and the EPG panel, exiting back out to the exterior.

Partially ventilated systems refer to when there is only one gap present at either the top or bottom of a window, and a sealed or closed system refers to when there is no gap present at either end. Although historical closed systems can be effective in terms of protection from weather, vandalism and increased insulation, a closed system is wholly ineffective in controlling condensation, as there is no chimney effect airflow through the interspace, the defining feature of an effective system. A sealed EPG system can cause moisture to accumulate on nearby walls, as the windows are no longer the coldest surfaces in the building. This moisture buildup can eventually lead to issues for the whole building such as increased mold growth on walls.

Design considerations for an effective EPG system:

Each design component of an effective EPG system is often determined, or at least influenced, by the size of the stained glass and the profile of the surrounding stone. However, general guidelines for each element are discussed below:

- Distance of the stained glass window to the protective glazing panel: under 10 mm can compromise the airflow performance but a gap over 60–80 mm provides no additional

benefit. A 50 mm gap is often used. Ideally the interspace needs to be clear of any obstructions for optimal airflow.

- Ideal size of gap at the top and bottom of the framed stained glass panel is between 12-15mm, If the profile of the stone does not allow at least a 12mm gap, the panel can be installed at an angle, where the base edge of the window protrudes inward toward the interior of the church.
- Size of the lead upstand at the base of the system depends on the height of the window from the ground. The lower the window is to eye level, the higher the upstand, typically between 20mm-40mm.
- The lead flashing that sits over the masonry sill is code 4 (appx 1.8mm) thickness. This protects the stonework from erosion caused by water absorption and repeated rain impact over many years.
- Copper tabs are generally placed 300mm up the window, (the wider the window the closer the intervals)

Appendix 6: Cold Colour Mediums Information

Maimeri paints are oil based restoration paints that come in a variety of different colours, made for inpainting or retouching in restoration projects, including stained glass. In keeping with best practice restoration principles they are designed to be reversible or removable with turpentine or mineral spirits. Oil based colourants like maimeri restoration paints come in many different colours, and when painted over edge bonded cracks on brightly coloured glass can be very effective in concealing such restoration interventions.

Gold-size is an oil-based medium traditionally used in glass gilding but can also be used as an effective cold-colour restoration medium. When mixed with glass paint, it produces a texture closely resembling that of traditional stained glass paint. Due to its oil-based composition, gold-size offers greater resistance to moisture and environmental

weathering compared to many water or alcohol-based alternatives, making it particularly suitable for use in exposed conditions.

As maimeri restoration paints and gold-size mediums are not actually fired onto the base glass, performance of these mediums is strongly tied to environmental conditions (light, humidity, temperature). Under poor conditions the ageing effects like yellowing, cracking, change in gloss and hardness are accelerated.

Appendix 7 : Plating Information

The process of plating a piece of glass can be carried out through various means. The Fellow came to understand through their studio placements that the process usually begins with 1-2mm float glass being cut the size of the original glass and used as the back plate. From here, there are different approaches as to how the plate is manipulated and adhered to the original glass. If the original piece of glass is particularly undulating, attempting to adhere a flat plate to the face of the glass would prove difficult, and may create points of tension, or create the opportunity for condensation, insects or dust to enter into the space between the two pieces. To address this, many studios across England and Europe choose to slump the back plate to the exact topography of the historic glass by pressing the profile of the original glass into whiting, and then taking the 1-2mm backplate to slumping temperature in a kiln to mold to the exact profile face of the original.

In terms of joining the original glass to the back plate, some studios choose to use copper-foil around the perimeter edge of both primary and secondary pieces of glass, however the Fellow had the opportunity to learn the process of adhering the back plate to the glass using adhesives like silcoset 153. In this process, the plate is cut approximately 0.5-1mm smaller than the original, and once the edges of both plate and original are cleaned thoroughly with acetone, the silicone is applied along/around the small step between the plate and original, securing both pieces against one another.

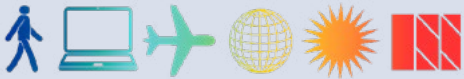
Back plates are also a useful conservation tool when addressing paint loss. In line with modern conservation principles, while it is mostly unacceptable to paint cold colour mediums onto the face of the historic glass, it is acceptable to paint specific missing areas onto a back plate, fire the plate and adhere to the back of the original glass.

This practice offers the opportunity to increase the legibility of a stained glass design, while also preserving any original material. However, as stated in section 4.1 of the CV, interventive conservation and restoration methods, “should not be carried out indiscriminately on the whole pane.”⁹ Meaning it would not be appropriate to dismantle large sections of paint loss affected glass just to add backplated painting across the whole window without justification. This practice is most effectively used when pieces are already coming out for restoration, where small amounts of backpainting may assist readability in areas significant to the design, referencing the CV once again section 4.5.2 where “Exceptional and selective interventions may also be justified by the need to regain some of the legibility of the artwork”⁹

08

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