

A stained glass artwork depicting the Resurrection. Jesus, with long brown hair and a beard, is shown rising from the tomb. He is wearing a white shroud that is partially open, revealing his chest. His right arm is raised, pointing upwards. To the left, an angel with long, wavy brown hair and a green robe is looking up at Jesus. The background features a greenish-blue sea with several crosses in the distance. The artwork is composed of various colored glass panels, with some sections appearing to be cut out or separated, suggesting a restoration process. There are small white labels with numbers like '13' and '25' on some of the glass pieces. At the top, the text 'SCOTTISH STAINED GLASS' is written in white, flanked by green square symbols.

SCOTTISH STAINED GLASS

AN ESSENTIAL GUIDE TO:
STAINED GLASS RESTORATION



My name is Martin Faith, and over 25 years ago I moved to the United States and founded Scottish Stained Glass. Over the years we've designed, built, or restored more than 70,000 windows in homes, businesses, and religious buildings across the US.

Today much of the stained glass in churches, chapels, and synagogues all across the United States is reaching the age, around 75-100 years old, when the cracking, buckling, and folding are becoming critical. Decisions will need to be made concerning whether the windows will be saved and restored for the next 100 years, or might need to be replaced with new designs.

I have created this brochure so that organizations across the country have a resource with which to begin this stressful process. We intend this to be a useful resource for groups working with any stained glass studio and will help ensure that you understand the process and ask the right questions.

Please don't hesitate to contact me directly if you ever have any questions.

Sincerely,

Martin Faith

Founder & President of Scottish Stained Glass

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QUICK ASSESSMENT GUIDE

DOES YOUR GLASS NEED RESTORATION?



Things to look for to determine whether you church stained glass windows need restoration:

- 1. When you stand underneath or beside the window do you see any bulging?
Does the window appear to have a concave or convex appearance?*
- 2. Is there excessive dirt buildup between the lead and the glass which cannot easily be cleaned off?*
- 3. Are any of the glass pieces cracked?*
- 4. Can you see any light gaps?*
- 5. Have any of the reinforcing bars detached from the stained glass panel?*
- 6. Is any of the lead soft enough to bend with your fingers?*
- 7. Has any of the lead came, the grooved leaded strips supporting your stained glass, cracked?*
- 8. Have any of the soldered joints cracked?*

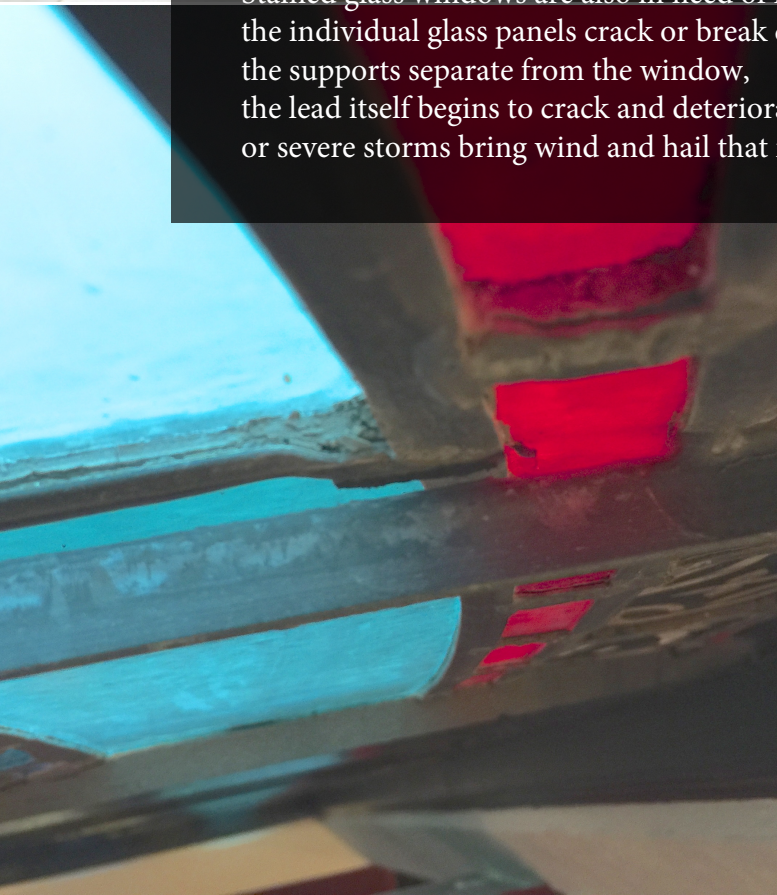
If the answer to any one of these is yes, then your windows may be ready for restoration

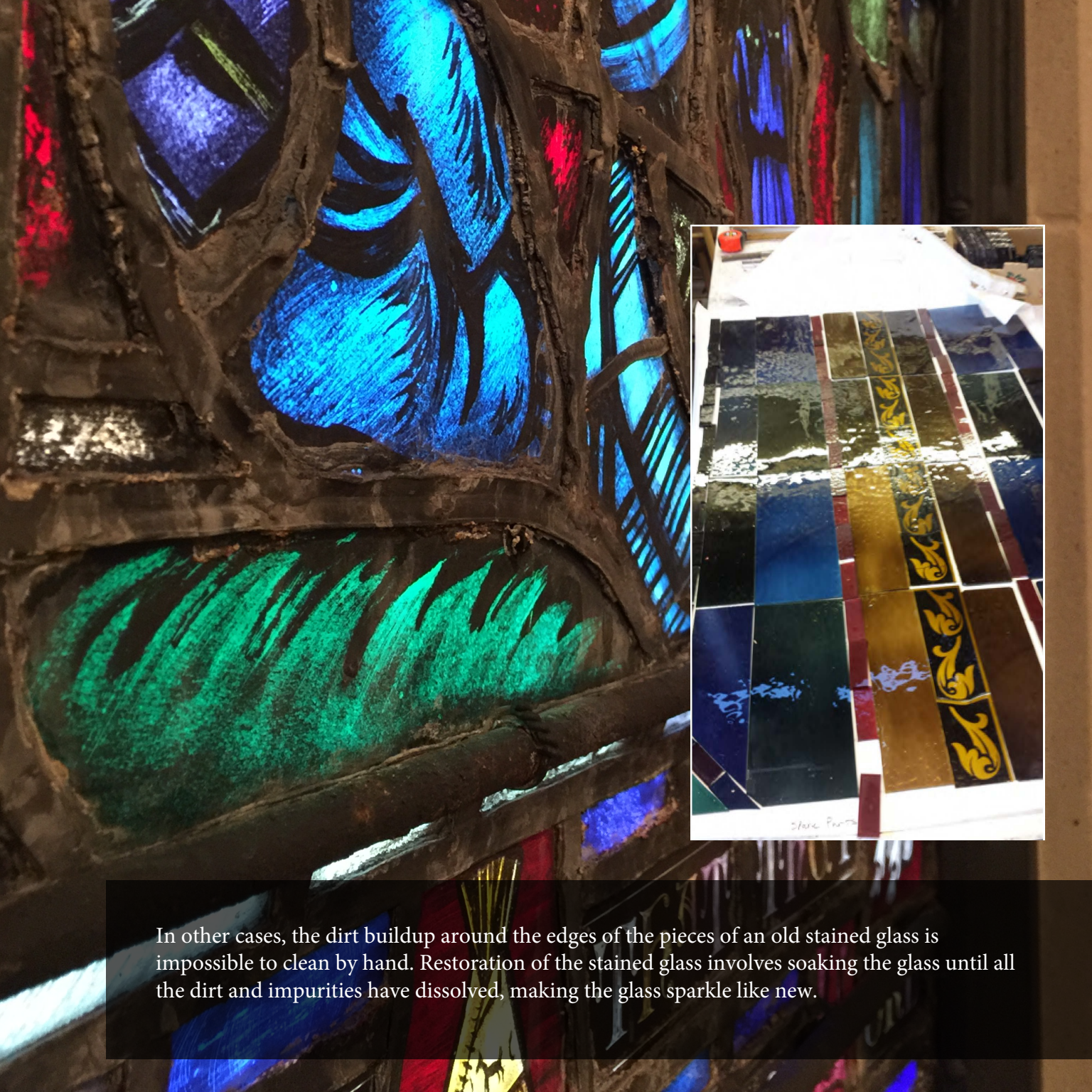


Stained glass window in need of restoration due to the buckling of its lead came.



Stained glass windows are also in need of restoration when:
the individual glass panels crack or break due to stress,
the supports separate from the window,
the lead itself begins to crack and deteriorate,
or severe storms bring wind and hail that may impact structural integrity.





In other cases, the dirt buildup around the edges of the pieces of an old stained glass is impossible to clean by hand. Restoration of the stained glass involves soaking the glass until all the dirt and impurities have dissolved, making the glass sparkle like new.

STEP-BY-STEP RESTORATION PROCESS



1. *The existing leaded/stained glass will be removed and brought to our workshop. Temporary, textured glass will be installed if required.*
2. *A computer generated pattern/template or hand-done rubbing is made for each window.*
3. *The windows will soak in a bath to loosen the cement for up to two weeks. Each window is then completely taken apart. We save the unbroken glass while safely disposing of the old, damaged lead.*
4. *Replacement pieces are made to replicate the broken ones.*
5. *The windows are rebuilt using new leading.*
6. *The lead used will be specially manufactured to have a profile similar to the existing lead, but with a higher strength and, wherever possible, the lead will be steel reinforced on the inside.*
7. *Each lead joint is soldered using a molten mixture of lead and tin.*
8. *The panels are then cemented for extra strength and waterproofing by forcing a thin black cement between the lead and the glass.*
9. *We clean and polish the glass.*
10. *Reinforcement bars are added wherever necessary.*
11. *The finished product is returned to the church and reinstalled.*
12. *Additionally, often times the framing also requires restoration and in certain cases, a new protective glaze is installed.*
13. *Stand back and admire the stained glass for the next 100 years or more!*

Why Does Aging Stained Glass Require Restoration?

Glass is a fragile substance, but one that is not usually affected by weather, moisture, or even gravity if it is properly supported. If the glass has not been smashed or damaged in any way, it's usually not the reason a stained glass panel needs restoration: the problem is the lead.

Stained glass is held together with grooved lead strips known as “comes”. The pieces of cut glass that make up the pattern are inserted into the grooves in the comes and held securely in place. Although lead is a very heavy metal, it's also very soft, making it susceptible to the effects of gravity over time. Heat, humidity, and oxidation also play a role in the degradation of the stained glass window's structural integrity. Came, whether lead, zinc, or copper, will deteriorate naturally over time from the elements as well as from thermal expansion and contraction.

Large stained glass windows are extremely heavy. Once the lead starts to sag, a chain of events is slowly set into motion. If there are steel brace bars supporting the windows, they can be pulled free from the lead, adding to the problem. The stress of this sagging and loss of support can cause the pieces of glass to crack or even fall right out of the window. This can cause a safety hazard to any people who might be sitting under or near the affected windows.





Other factors that might cause stained glass to need restoration include the aging and deterioration of the window frame. Wood sashes and frames decay over time if they haven't been properly taken care of. When the frame decays, warps, rots, or becomes less stable, this can also cause sagging of the window and cracking of the individual pieces of glass. At this point, even a strong gust of wind or the vibration of a passing truck might be enough to jar loose a piece of glass.

Although there are many factors that cause stained glass windows to require restoration, there is good news. Since the effects of time and gravity on stained glass have been studied over the past century, restoration with modern methods can make antique stained glass windows stronger, more stable, and last longer than when they were originally built.

* A note about Plexiglas: Many churches in the past have tried to protect their stained glass windows from vandalism by installing a sheet of Plexiglas to their exterior. This well-intentioned but uninformed action causes such severe heat to build up between the Plexiglas layer and the stained glass that the warping and deterioration of the lead is greatly accelerated. All protective glass or Plexiglas must therefore be vented. Plexiglas will also yellow over time. Many churches are now using tempered safety glass as an alternative. This too, however, must be properly framed and vented.

When to Consider Stained Glass Restoration



By standing beneath a stained glass window and looking up at it, the viewer can usually tell if the window is sagging, bowing, or becoming distorted. Contact a professional at the first sign of trouble. Restorations should only be done by experienced stained glass restoration experts.

Can the windows be repaired in place? That depends on exactly what is happening to them. Beware of inexperienced glaziers who will try to re-brace the windows with new steel supports, or flatten them back into place. Although this can seem like an attractive, low-cost alternative to the more expensive full restoration, this type of “repair” can actually cause severe pressure on the window which will hasten the cracking of the glass and the window’s inevitable deterioration.

Proper restoration is done by removing the windows completely. It is always best performed upon the first sign of buckling or bowing lead, even if none of the glass has cracked. It can be expensive to match the color, texture, or finish of hundred year old glass, so it’s always best to do the restoration before any of the original glass is destroyed. Minor sagging and bulging is to be expected in an old window and may not require immediate action, but generally, these problems will grow worse. Taking care of them as soon as possible can save significant amounts of money.

EIGHT STEPS TO RESTORATION



Depending on the size of the windows, the restoration process can take many months to complete. There are various stages that need to be performed to receive optimal restoration of the windows.

1. Removal. The antique stained glass needs to be removed from the frames and temporary glass will be installed. It's important to use exactly the right tools for this and to know how the glass was installed in the first place, in order to complete this task without breaking pieces of the stained glass.

2. Cleaning. The beauty and transparency of stained glass can be substantially diminished over time with the buildup of soot, grime, and even residue of the incense or candles that are burned in many churches. Some stained glass windows were covered with a layer of varnish or other type of lacquer, which may have yellowed over time. The first step in a restoration is to remove grime, old coatings, and anything else on the glass. Windows are soaked in a bath of cleansing solution for up to 2 weeks, which removes the grime of a century, along with dissolving any old cement, putty, caulking, glazing, or other substances. Dissolving a hundred-years' accumulation of grime doesn't just clean the glass and restore its luster; it makes the windows easier to disassemble.

Acidic, caustic, or abrasive cleaners can damage glass and should never be used. If the original glass is hand painted, sample areas should be tested to ensure the paint does not dissolve when the cleaning solution is applied.



3. *Disassembly.* The stained glass panels are then taken apart completely, piece by piece. Photography, rubbings, or computer software are important parts of a stained glass restoration project, to document the design and ensure that after taking it apart, it can be perfectly reassembled. The pieces are numbered, cleaned again, and set aside for reassembly.

4. *Glass Replacement.* All glass in good, reusable condition is carefully catalogued and stored so that it can be easily reassembled. It's always advisable to reuse as much original glass as possible. If there are badly cracked, chipped, or missing pieces of glass, they'll be replaced with new, matching glass.

A qualified stained glass restoration expert should have many available resources to match all types and colors of glass. Glassmakers of yesterday (and today) carefully guard their glassmaking secrets, so it is possible that some pieces of damaged glass will be difficult to match . . . but rarely impossible. Wonderful custom glass studios exist worldwide, including the company that most likely supplied much of the glass used in your original church windows.



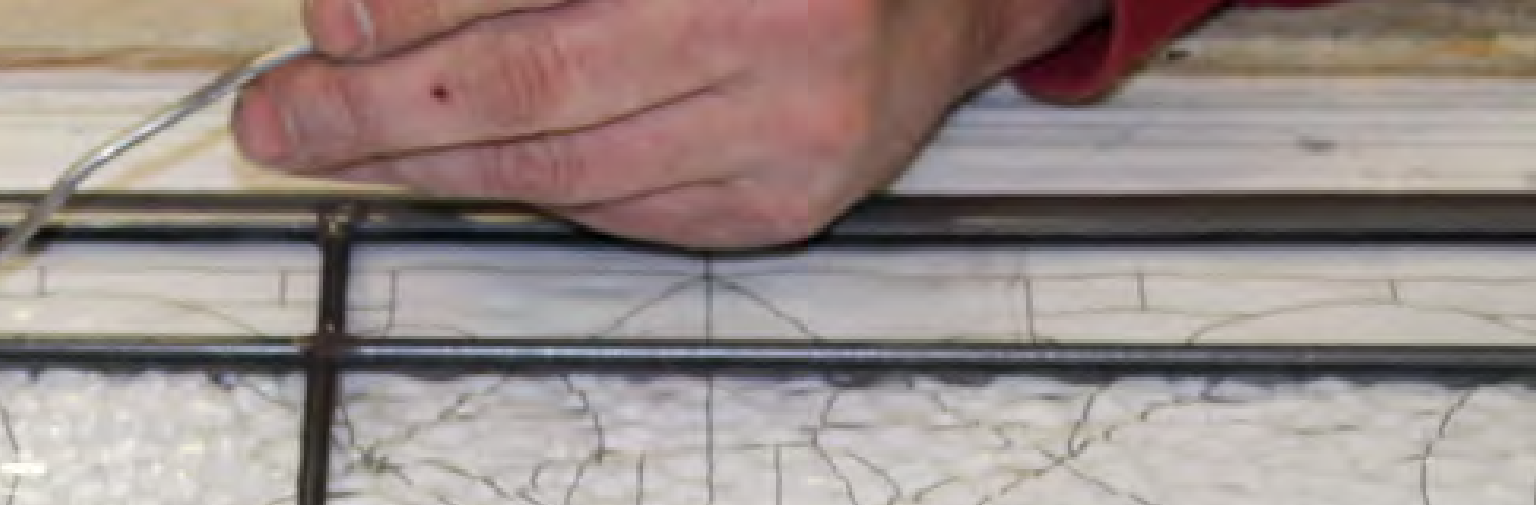




5. *Reassembly.* The windows must be fully reassembled, piece by piece, into the original design. None of the old lead is reused. The new lead came should be specifically designed to match the original lead, and possibly internally reinforced with a stronger metal for extra strength.

Lead came is made from an alloy that combines a fine grain structure and high strength. It starts with 100 percent pure lead to which small quantities of tin, copper, antimony, and bismuth are added. The came is still over 99 percent pure lead but you can now stretch the lead and still maintain a fine grain structure. This alloy also prevents oxidation, which makes for easier soldering and prevents tarnishing. If extra strength is required, four percent and six percent antimony can be used to increase the hardness of the lead. If an off-the-shelf lead came does not exist to match the original lead profile, then the restoration expert will have a dye made and extrude the exact profile.





The panels are cemented after assembly. A thin, usually black, cement mixture is forced into the channel between the lead and the glass. The glass is cleaned and polished to remove all traces of the cement from the viewable area of the panels. This cement hardens in a few days.

After assembly/cementing of the panels, reinforcing bars are attached to the interior side of the panels where extra support is needed. The bars must be left long enough to be installed all the way into the framing of the windows to allow the weight to be taken by the window frames. A common mistake is to cut off the rebars level with the outer edge of the panel or taper them at the edges. If there is no obvious way to position a rebar without detriment to the design of the glass, the steel rebars can be bent into almost any shape. Proper structural support will help the window last another hundred years or more without the reappearance of the same structural problems originally caused by the softness of the lead and insufficient reinforcement.





Restoration often includes not only the removal of old windows but also the installation of new clear glass and modern window frames that will keep the restored glass looking beautiful for centuries to come.

6. Reinstallation. The window is now ready to be reinstalled. Many factors must be taken into consideration. In fact, every reinstallation of antique stained glass should be a custom installation specifically designed for the size and shape of the window as well as the surrounding frame. The condition of the window frame might need to be improved, or even replaced.

In a proper installation, the weight of the stained glass must be evenly distributed into the framing around the glass. As previously mentioned, this generally means making steel brace bars that are longer than the originals and notching them into the framing. (This type of steel bracing might not have been done originally, but proper bracing can add many more decades to the life of stained glass.)

7. Protection. The newly installed stained glass needs to be protected from the elements at all times with a pane of protective clear glass. However, this glass must be properly vented to prevent the kind of heat buildup that will deteriorate the lead. Venting can be achieved either from the inside of the church or from the outside. Both top and bottom vents are required to allow the heated air to escape from the top and pull in cooler air from the bottom. Protective glass or polycarbonate should be framed in on the outside in such a way that allows for occasional removal and cleaning.





Severe weather, including wind, can sometimes cause leaded windows to separate.

8. *Stand back and say, “Wow”.* The newly restored glass should look like it’s brand new. The glass doesn’t deteriorate unless it’s broken, so now that decades of dirt and grime have been removed and the old lead came has been replaced, the owners of antique glass panels can see the amazing beauty that was first observed by their ancestors, three or four generations ago.

* **Important tip:** If the restoration of stained glass windows is part of a larger building restoration, always have the windows removed before the other repairs begin. Severe damage to the stained glass windows can be caused if they are left in place during construction work. Their removal and reinstallation should be a carefully planned aspect of the larger preservation project. Major repairs to windows are sometimes part of a larger preservation project. In such cases, the risk of damaging the windows can be very great if their removal and reinstallation have not been carefully planned.





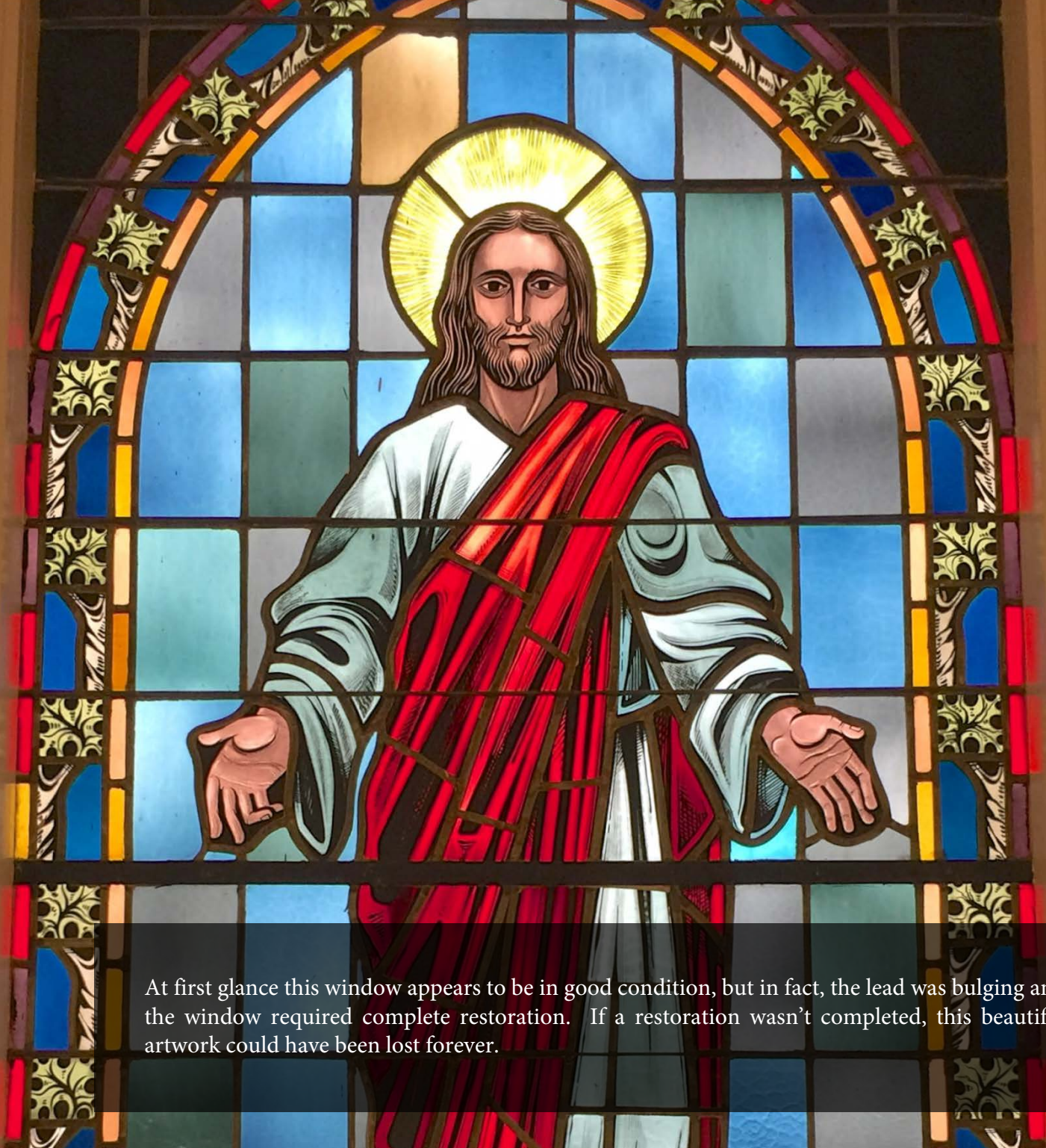
Fully restored windows sparkle as if brand new.

FINDING THE RIGHT RESTORATION STUDIO



Antique religious stained glass is a part of the church's history. Make sure only the best-qualified stained glass professionals work on its restoration. Before undertaking any stained glass restoration work, churches and other building managers/owners should vet stained glass studios carefully to determine their level of expertise.

- *Does the studio have an A+ rating with the Better Business Bureau?*
- *Can they offer references?*
- *Do they have insurance and workers compensation? Normal liability insurance coverage would be \$5 million.*
- *Do they have certification pursuant to the Toxic Substance Control Act?*
- *Can you inspect other similar restoration projects the studio has completed?*
- *Will there be full documentation of any work done for your records?*



At first glance this window appears to be in good condition, but in fact, the lead was bulging and the window required complete restoration. If a restoration wasn't completed, this beautiful artwork could have been lost forever.

AFTER THE RESTORATION



Stained glass has a long history in church windows around the world. Although originally installed in medieval churches as a teaching mechanism, to illustrate scenes or lessons from the Bible to a largely illiterate populace, church stained glass has become synonymous with upliftment and inspirational worship. After reinstallation, the effect of a stained glass restoration is absolutely stunning. Old church windows which were dull and taken for granted become a source of immense joy. Windows that undergo restoration which might have been lost forever, can now shine for generations to come.



Original glass painting will vary greatly and the restoration expert must be able to match brush strokes of the original artist.



Before



After



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Scottish Stained Glass will consider restoration work all across North America.