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IWCA

Guide to Architectural Glass for Professional Window Cleaners

Disclaimer

Disclaimer: The information in this guide was compiled from various industry sources and represents the current best methods and practices employed for commercial cleaning of glass. This guide is presented for informational purposes only. All sample methods and procedures herein should serve as a guideline, which can be used to formulate applicable policies and procedures for any member company. We trust that incorporation of any or all of these samples will be dependent on the members current operations, and present these samples that they may serve as a helpful platform for this endeavor.

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Introduction

The International Window Cleaning Association has provided glass information to window cleaners for close to two decades. The Guide to Architectural Glass is written for window cleaners in hopes to achieve an industry standard for cleaning, maintenance and restoration of glass.

Glass is one of the most valuable building materials used in construction. Building owners have a responsibility to protect the integrity of the glass, preserving it's beauty and transparency. Window Cleaners, by process, maintain its beauty and restore glass surfaces when lack of protection, maintenance or when abusive practices have compromised the surface.

It is important to understand that science ultimately provides a true pathway to knowledge about glass. The transparency of glass, when cleaning, requires a level of knowledge to be able to identify various issues on surfaces and in the insulating glazing unit. The goal of this document is to simplify scientific and industry knowledge into an easily referenced guide that will promote practices, communication and training for professional window cleaners.

Please consider bookmarking this document or adding it to a device home screen as an application. Keep this document close to those performing operations or engaging in problem resolutions in the field. The IWCA expects to review and update this information annually, as glass products and industry knowledge changes.

What is Glass?
Composition and Manufacturing of Architectural Glass

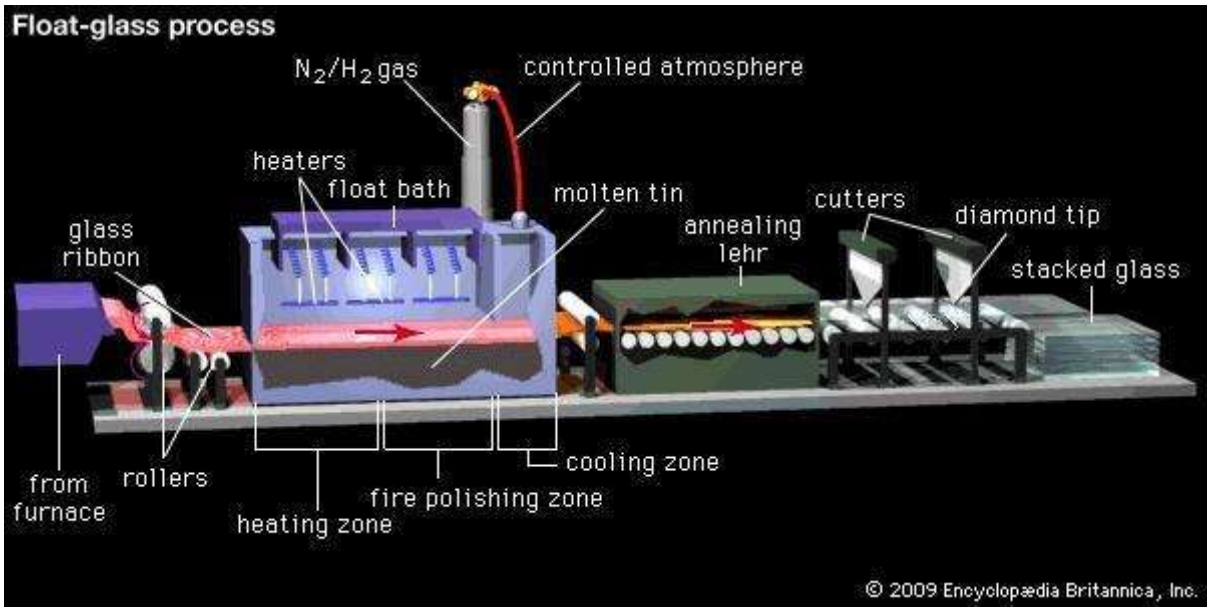
The Float Glass Process

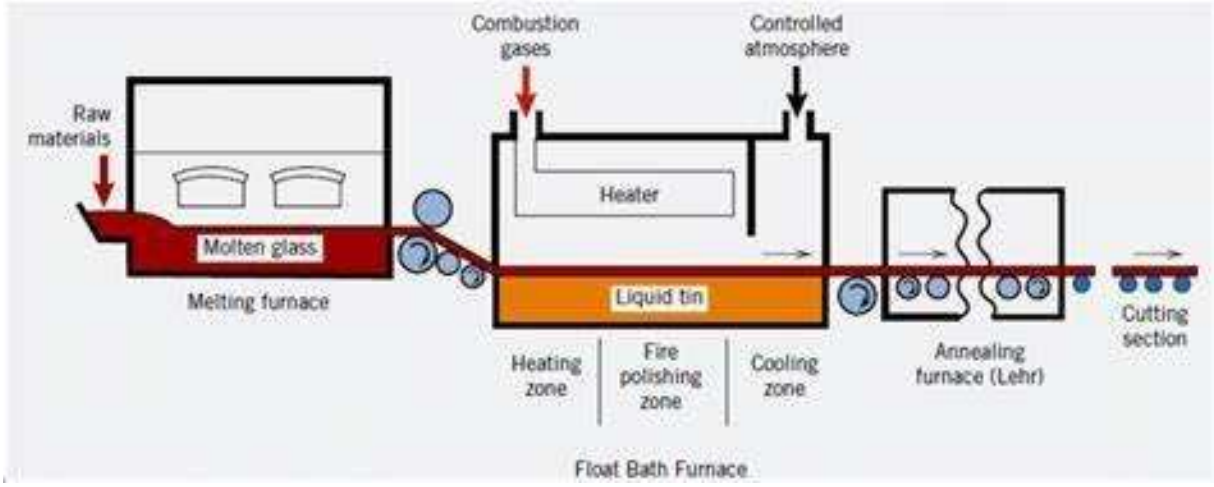
The Float Glass Process is used to make high-quality, flat glass for the construction and automotive industry. Developed in 1959, this highly technical manufacturing process involves using some of the earth's most abundant raw materials to produce a durable glass product. The main ingredients in glass are:

- Silica Sand: Makes up 60% of glass
- Limestone: Contributes strength properties to glass
- Soda Ash: Helps glass endure a range of temperatures without melting
- Dolomite: Contributes to glass' resistance to melting
- Glass Cullet: Commonly known as 'broken glass'; this accelerates the melting of glass as it goes through the float glass process.

In the float glass process, molten glass from the furnace flows by gravity and displacement onto a bath of molten tin where a continuous ribbon is formed. The glass ribbon is pulled or drawn through the tin bath and upon exiting is guided on rollers through an annealing lehr where it is cooled, under controlled conditions, until it emerges at essentially room temperature. The product is now flat, fire-finished, has virtually parallel surfaces and is annealed glass in terms of strength. Automatic cutters generally are used to trim the edges and cut across the width of the moving ribbon. This creates glass lites in sizes that can be shipped or handled for further processing. The float glass process accounts for almost all the flat glass presently produced in the United States.

Float Glass Process:



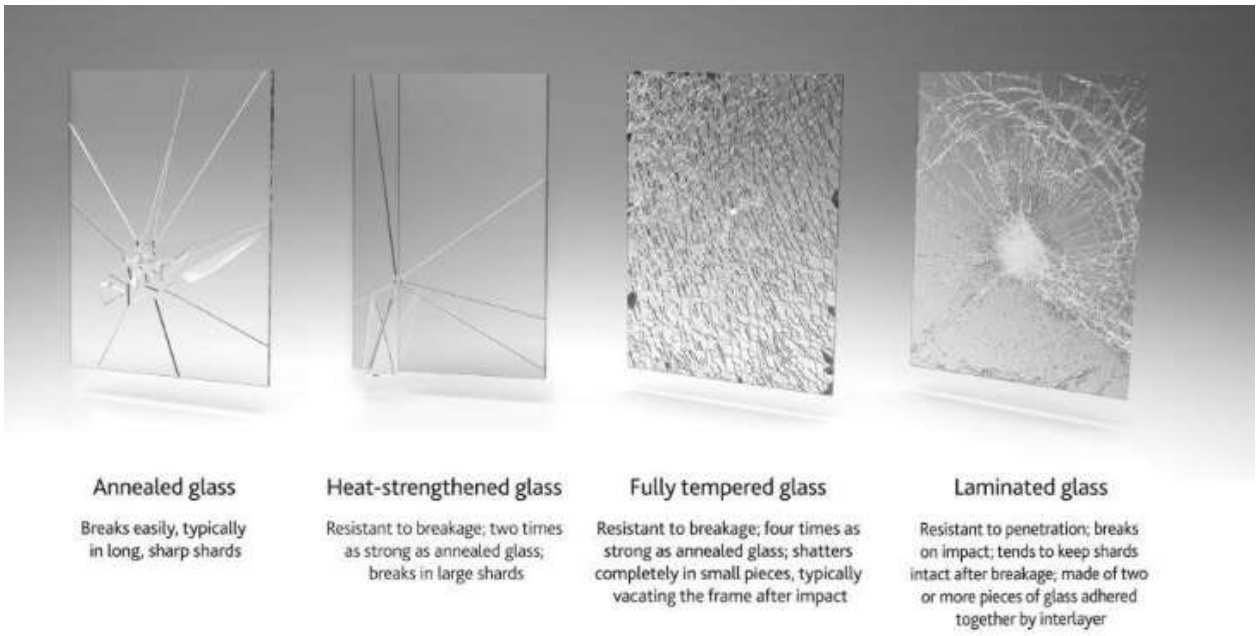


Types of Glass

Glass is available in many different forms and compositions that are used in various applications. To get a better understanding of these variations, window cleaners benefit by identifying the different types of glass that will be encountered in the field.

Glass can be identified by the following methods:

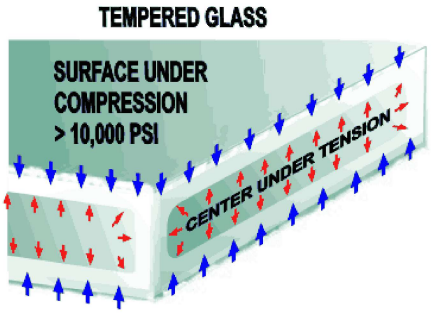
- Glass Manufacturing Stamp Types; Porcelain, acid etched…
- Sticker on glass
- Sticker on sash rails
- Manufacturer name on hardware
- On glass spacer in the insulating glazing unit



ANNEALED GLASS is a basic product formed from the annealing stage of the float process. The molten glass is allowed to cool slowly in a controlled way until it reaches room temperature, which will relieve any internal stresses in the glass. Without this controlled slow cooling, the glass would crack with relatively little change in temperature or slight mechanical shock. Annealed glass is used as a base product to form more advanced glass types. Annealed glass in the field will be devoid of any markings etched or applied to the pane.

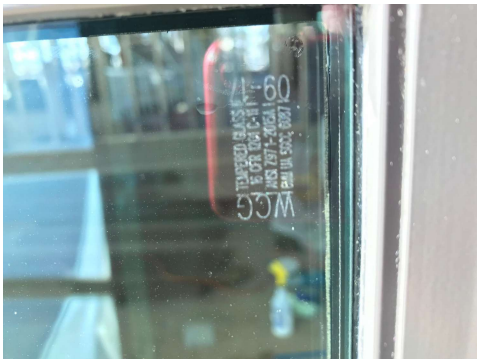
HEAT STRENGTHENED GLASS is semi tempered or semi toughened glass. The heat strengthening process involves heating annealed glass back up to about 1000-1300 degrees fahrenheit and then cooling it quickly, although not as fast as with tempered glass. The heat strengthening process increases the mechanical and thermal strength of annealed glass, making it twice as tough as annealed glass of the same thickness, size and type.. When it breaks the fragments are similar in size to annealed glass, but with a greater likelihood of staying together. Heat strengthened glass can be identified by a small etched marking usually found in the corner of the pane.

This glass is not often used in railings or similar structural applications because of its limited strength compared to tempered or toughened glass, although it is sometimes specified when there is concern about tempered glass fracturing into thousands of small pieces.

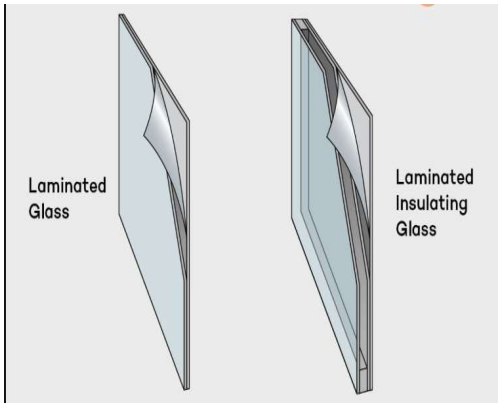


TEMPERED GLASS is the most common type of glass used in balustrades or similar structural applications. Annealed glass is heated to about 1300 degrees (F) by conduction, convection, and radiation. The cooling process is accelerated by a uniform and simultaneous blast of air on both surfaces, known as “quenching”. The different cooling rates between the surface and the inside of the glass produces different physical properties, resulting in compressive stresses in the surface balanced by tensile stresses in the body of the glass.

This process makes the glass four to five times stronger and safer than annealed and two times stronger than heat strengthened glass. This glass can be clearly identified in the field by inspecting the corners of the glass where an etched marking can be found outlining the tempering process, batch information and tempering company.

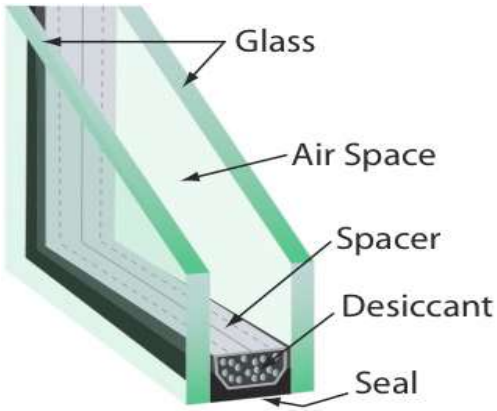


The counteracting stresses or surface compression gives the tempered glass its increased mechanical resistance to breakage, and when it does break, causes it to produce small, regular, typically square fragments rather than long, dangerous shards that are far more likely to lead to injuries.



LAMINATED GLASS tempered and heat strengthened glass can be laminated, however the most commonly used finished product is two sheets of annealed glass,

laminated together with a 1.52mm thick Polyvinyl Butyral (PVB) interlayer.
Laminated glass offers many advantages. Safety and security are the best known of these, so rather than shattering on impact, laminated glass is held together by the interlayer. This reduces the safety hazard associated with shattered glass fragments, as well as, to some degree, the security risks associated with easy penetration. As this glass is usually used in applications where the glass must maintain the envelope regardless of if the pane is cracked or intact, (balustrades/security glass) this glass is most easily identified if the edge of the pane is visible. If a glass panel breaks or shatters it is highly unlikely that both laminated panels will break at the same time, which means that the remaining panel and interlayer will support the broken glass and keep it in place as edge protection until it is replaced or secured suitably.
https://www.basystems.co.uk/blog/2016/10/glass-types/

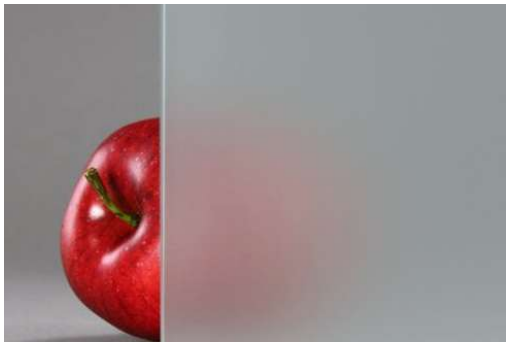


INSULATED GLASS consists of two or more plies of glass separated by an aluminum or other type of spacer and is filled with air, or in some cases, noble gases (like argon) to influence the element's insulating value. The combination of two panels of glasses and the trapped air is what makes insulated glass a superior energy-efficient method of glazing.

Inherently, insulating glass demonstrates high thermal performance by reducing heat gain in the summer months as well as heat loss and condensation in the winter months. Among other benefits, the use of insulating glass can contribute to lowering cooling and heating costs, UV transmission, while maintaining wind load strength. Insulating Glass Units (IGU's) can be made with many different types of glass. However, in most architectural applications, it consists of two tempered or annealed panels connected by the spacer. To identify an Insulating Glass Unit (IGU), simply look to see if there is one or multiple panes encased within the frame.

LOW IRON/ EXTRA CLEAR GLASS is created by reducing the amount of iron within its content which removes the green tint inherent in standard glass. Extra clear glass has an almost completely transparent appearance meaning it has limited sun reflection properties. It is particularly useful in solar energy applications where it is important that the glass color lets light through to reach the thermal tubes or photovoltaic cells. Anti-reflective properties can be further increased by applying a special coating on the low-iron glass. It's widely used in windows or facades as it offers brilliant clarity, which allows occupants to appreciate true colors and to enjoy true-to-life views. Because this glass has low to no iron in the chemical structure, this type of glass tends to be softer and more susceptible to surface damage when cleaning. To identify this type of glass, look for the absence of any green coloration to the pane.

DECORATIVE GLASS there are various decorative glass types that offer a variety of design options for residential or commercial solutions. This glass is most often simply colored annealed glass where the color has been added during the manufacturing process so as to dope the glass throughout the composition. This is not to be confused with films, or graphic prints that have been embedded with a PVB layer between two panes in a lamination.



ACID ETCHED is a type of glass that has been chemically treated with an acidic material, such as hydrofluoric acid, to produce a surface finish that will diffuse transmitted light, reduce glare and have a “frosted” appearance. The treatment on the glass is used to diffuse light, reduce glare, and create privacy.

https://www.glasscon.com/blog/8-common-glass-types-properties-applications-potential

COATED GLASS Surface coatings can be applied to glass to modify its appearance and influence or improve its mechanical properties, such as low maintenance, special reflection/transmission/absorption properties, scratch resistance, corrosion resistance, etc. Coatings are usually applied by controlled exposure of the glass surface to vapors, which bind to the glass, forming a permanent coating. The coating process can be applied while the glass is still in the float line with the glass still warm, producing what is known as "hard-coated" glass. Alternatively, in the "off-line" or "vacuum" coating process, the vapor is applied to the cold glass surface in a vacuum vessel.

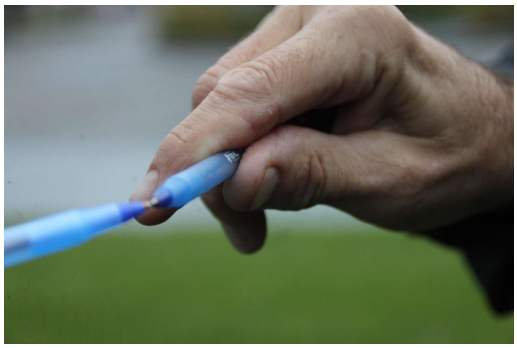
AFTERMARKET WINDOW FILM is a thin, multi-layered polyester material that incorporates many different layers to control different properties, including Ultra-Violet (UV) light, heat, glare, and privacy. Window film comes in a variety of performance levels and shades. As it pertains to cleaning, it is important to note that any ammonia based cleaning agents can cause irreparable damage to the installed film. As such, caution should be taken when selecting the appropriate cleaning agent and tooling. For more information check out https://www.glasstintusa.com/faq/

REFLECTIVE GLASS is any type of glass with a metallic coating that cuts off solar heat. This special metallic coating also provides a one-way mirror effect, preventing visibility from the outside and thus preserving privacy. Reflective glass is used primarily for structural façade glazing.
http://www.glass-academy.com/reflective-glass/

LOW-E COATINGS (low emissivity) coatings reflect heat (both solar and ambient) in order to help to keep the structure cool in the summer months and reduce the amount of heat escaping through the glass in the winter months. The objective of a Low-E coating is to improve comfort while reducing energy costs.

Windows with Low-E coatings reduce the amount of heat transmitted through the glass. The coatings are made up of a series of almost invisible layers of various materials and rely on one or more precious metal layers (e.g. silver) to reflect exterior and interior heat.
As well as reflecting heat, Low-E coatings can also reduce fading by partially reflecting damaging UV-rays and acting as a sunscreen for artwork, furnishings and floors. Current sputter-coated Low-E coatings are multi-layered, complex designs engineered to provide high visible light transmission, low visible light reflection and reduce heat transfer. High-solar-gain low-E coatings and low-solar-gain Low-E coatings are the two main types.

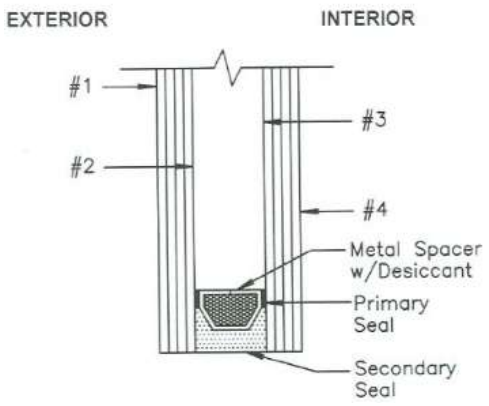
Identify Low E: Low E Coatings can only be identified when the manufacturing sticker still resides, on the sash rail sticker when tilting a residential window or when the thermal glass unit fails and moisture and air enter, starting to corrode the Low E Coating between the glass. When this happens, the sputter coat (metal) will appear as iridescent or metallic spots in the glass. This is most visible from the exterior since the light is reflecting off of the sputter coat. (See Low E Corrosion below)
https://www.guardianglass.com/eu/en/products/glass-type/low-e-glass



THE PENCIL TEST: A simple test to determine the location of the reflective coating is to touch the point of a pencil to the glass surface. If the reflection of the pencil point meets the real pencil, the coating is exposed on that side. If there is a gap between the pencil point and the reflections, the coating is not exposed to that side of the glass.

Glass Installed in Units

Insulating Glazing Units include two or more lites of glass separated by spacer material(s) incorporating a drying agent (desiccant) and hermetically sealed around the perimeter with one or more sealants. The greater the number of lites, the more heat and noise insulation there will be. Manufacturers also produce multiple pane IGUs that use a combination of glass and plastic. These may be less expensive and easier to install than all-glass IGUs.



Glass Surface Orientation/Designation the numerical identification of a specific glass surface relative to the exterior surface of the assembly. The first surface (1) is the exterior surface (facing the sun in the diagram below) with each consecutive glass surface identified in order from exterior to interior with the last (highest number) surface being on the interior of the assembly.

Similarly, the outboard lite is the glass pane on the exterior side of the IGU, facing the exterior of the building. The inboard lite is the glass pane facing the interior of the building. The center lite is in the middle of the IGU, between the outboard and inboard lites. Each lite could be monolithic or laminated glass with or without a coating.

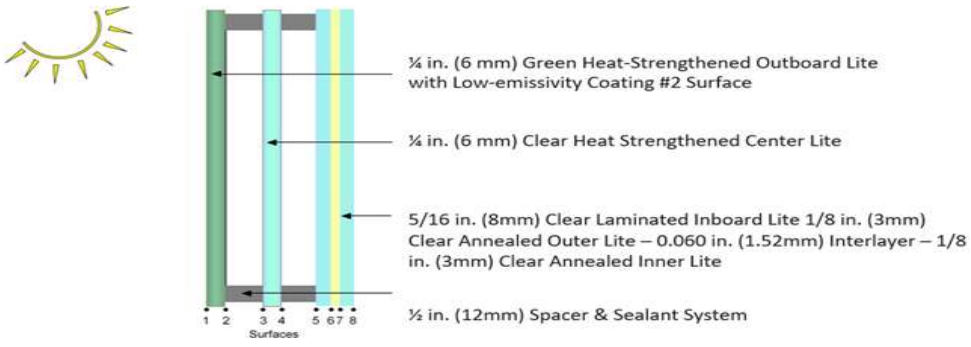


Figure Caption: Example of triple insulating glass unit with laminated inboard lite. For additional examples, refer to NGA Glass Technical Paper FB15-07 Describing Architectural Glass Constructions.

COMMERCIAL UNITS: In a commercial building, glass is glazed in various types of framing such as Aluminum, Glass, Steel, Vinyl, or Wood. Hi-rise construction is typically a curtain wall system, with fixed non-operable panes wrapping the building. The most common types of glass for commercial purposes include flat, plexiglass, tempered, laminated, spandrel, and security. Their applications include Malls, storefronts, and low-rise buildings. Flat glass is typically used for doors, fixed, and double-hung windows. Plexiglass is shatter resistant and useful in skylights, aquariums, and curtain wall construction. Spandrel glass is not see-through and is generally used as a decorative accent or to conceal a portion of the building's structure. Most commercial glazing systems are fixed.

CURTAIN WALL SYSTEM: This system is structurally very stable and energy-efficient. The type of glass depends on the local climate and Hi-Rise building code. (High-rise is more than 10 stories in height) Typically, the building owner will have built-in an electrically operated scaffold permanently installed on the roof. Additionally, OSHA requires the workers washing the windows to be tied off to prevent serious injury. The framing system is typically aluminum and can vary depending on climatic conditions.

FACADES: Building siding is typically over 10 feet in height, where structural loads are transmitted to the foundation creating stable safe facades. These window systems will usually employ glass that has superior UV resistance and greater ability to withstand extreme temperatures both high and low. The framing systems will vary depending on the application.

SPANDREL GLASS is not a see-through glass system and generally used as a decorative accent or to conceal a portion of the building’s structure.

WIRED GLASS is annealed glass having a layer of meshed or stranded wire completely imbedded as nearly as possible to the center of the thickness of the lite. Wired glass is considered to have approximately 50 percent of the strength of annealed glass of the same size and thickness, but the wire restrains the fragments from falling out of the frame when broken.

PLEXIGLASS: a solid transparent plastic made of polymethyl methacrylate.

Cleaning Architectural Glass

The professional window cleaning industry has developed three general categories that apply to cleaning operations; Routine Cleaning, Pure Water Cleaning with Water Fed Poles and Non Routine Cleaning.

Routine Cleaning and Maintenance

For routine maintenance, interior and exterior glass surfaces should be thoroughly cleaned as dirt and residue appear. Cleaning frequencies should be tailored to the individual characteristics inherent to the site conditions, as well as the severity of local environmental factors and atmospheric pollutants that vary from region to region. Before proceeding with cleaning, determine whether the glass is clear, tinted, or reflective. (See pencil test above in TYPES OF GLASS)

Cleaning tinted and reflective glass surfaces in direct sunlight should be avoided, as the surface temperature may affect cleaning results. Exterior cleaning should begin at the top of the building and continue to the lower levels to reduce the risk of leaving residue and cleaning solution on the glass that has already been cleaned. Cleaning procedures should also ensure wind is not blowing the cleaning solution and residue onto the already cleaned glass.

Prior to beginning a cleaning project, it is strongly recommended that window cleaners test clean a small area of one window. Next, it is best to stop and examine the surface carefully for any damage to the glass and/or any exposed coating. The ability to detect certain surface damage, such as light scratches, may vary greatly with the lighting conditions. Daylight conditions are needed to properly evaluate a glass surface for damage. Scratches that are not easily seen with a dark or gray sky may be very noticeable when the sun is at a certain angle in the sky or when the sun is low in the sky. In addition, because different backgrounds may yield different observations, cleaning methods should be tested on all glass constructions on the building.

Cleaning should begin by soaking the glass surfaces with clean water and a mild, non-abrasive glass cleaning solution. Apply generous amounts of solution to the glass surfaces with a brush, strip washer, or other non-abrasive applicators and lightly agitate to loosen the soil and debris. Immediately following the application of the cleaning solution, a window-cleaning squeegee should be used to remove all of the cleaning solutions from the glass surface. During a routine cleaning, care should be taken to avoid metal contact with the glass surface; razor blades and metal scrapers should not be part of routine cleaning. The use of sufficient water will help prevent abrasive particles from being trapped between the glass and the cleaning tools being used. However, the window cleaner needs to be diligent in keeping all abrasive particles from scratching the glass.

Routine Window Cleaning Tools

- Squeegee
- Strip washer
- White non-scratch scrubbing pad
- Microfiber or lint-free towels
- Chamois

- Bucket
- Surfactant (Soap)
- BOAB - bucket on a belt
- Squeegee holster
- Extension pole
- Extra towels & squeegee replacement rubbers
- Brush for sills
- Bronze or 0000 steel wool
- Magic Eraser

Routine Window Cleaning Products

- Professional glass cleaning concentrate
- Mild dishwashing liquids or equivalent

Cleaning With Purified Water & Water Fed Poles

While traditional window cleaning procedures rely on the use of soaps and detergents to emulsify and suspend surface dirt and contaminants to be removed with a squeegee, an alternative method utilizing highly purified water paired with physical agitation of the surface is showing increased popularity with window cleaners. The International Window Cleaning Association (IWCA) recognizes that this technology can offer a safer and more effective method for cleaning glass up to 60 feet above the ground. With the aid of a mechanical water purification/filtration system and a telescoping pole, it is possible to quickly and effectively clean windows without the need to utilize traditional cleaning tools and still achieve the desired result.

Pure water is one of the most effective solvents to remove most surface dirt and contaminants with mild scrubbing. The water is pumped up a telescoping pole via lightweight water tubing and delivered through jets within a brush at the end of the pole. The brush is used to agitate the surface suspending the organic materials (dirt, pollen, bird droppings, etc) while the purified water is flowing through the brush. A final rinse of the suspended organic materials follows the scrubbing and due to the fact that the water is ultra-pure, the windows do not need to be squeegeed and are able to be left to air dry. The process is often viewed as much safer than traditional methods due to the fact that it removes the need to utilize ladders.

Non-Routine Window Cleaning

Definition

While a specific definition for non-routine glass cleaning does not exist, in the technical bulletin co-produced by the National Glass Association (NGA) with GANA (Glass Association of North America) and the IWCA (International Window Cleaning Association), FB01-00 "Proper Procedures for Cleaning Architectural Glass Products" states, "Glass that cannot be successfully cleaned with traditional routine cleaning methodologies may require more aggressive and restorative techniques." As such any cleaning activities that require more intensive cleaning methodologies should be described as Non-Routine Window Cleaning.

Causes/Contributors For Non Routine Cleaning

There are countless causes and contributors to situations where successful glass cleaning will require non-routine cleaning and restorative techniques. Some of the most frequent are:

1) Extended periods of time between cleanings

a) Architectural glass left unmaintained for extensive periods of time (months or years) will very often require the use of Non-Routine Window Cleaning methods to restore the glass to original condition.

2) Run-off Conditions on Structures

a) Architectural glass, because of its physical location on a structure, will almost always be susceptible to vertical runoff from materials and surfaces that are located above them. Drainage patterns can range from concentrated "rivers" running vertically to more of a "sheeting" or comprehensive coverage.

b) Ledges and sills that receive the drips and splashes from above typically accumulate much heavier concentrations of runoff material that result in "splash-up" patterns on the glass.

c) Irrigation sprinkler systems can often lead to surface staining as either a direct result from overspray, or can cause leaching from adjacent structural materials which are relatively common when mineral staining is present on the glass. High mineral content water which comes from the irrigation system is deposited on the glass whenever the sprinklers are turned on. The water evaporates while leaving the mineral particles which accumulate over time. These minerals can chemically react

with trace minerals present in the glass to form a frosted or sometimes scaly pattern which will occur where the spray hits the glass.

d) Unsealed Precast concrete panels located on structures can and will leach out minerals contained within them, specifically calcium and lime, both of which can cause surface etching on the glass.

e) Caulking located in various joints throughout the building breaks down over time and those elements find their way to the glass surfaces located underneath them.

f) Metallic components located adjacent to or above the glass will oxidize over time. The various elements of these components travel down the structure and can etch any glass along the way.

3) Exposure to trades such as painting, sealant application, masonry, waterproofing, caulking, etc.

a) Trades that work near architectural glass may have a need to protect glass in the building envelope. The after-effects of certain trades can produce and leave materials that either cause damage or create a situation where non-routine cleaning methods become necessary to effectively restore the glass.

4) New glass, initial cleaning

a) While new glass might be thought to be able to be addressed with more routine window cleaning techniques, it is very common that these techniques will be insufficient in cleaning the glass surface. This is most commonly found in post construction and/or renovation cleaning.

b) New glass installations can be affected by:
i) Extended periods of time between arrival of new glass to a jobsite and the post-construction cleaning
ii) Runoff conditions on the structure
iii) Improper storage on the jobsite
iv) Exposure to trades that need to protect the glass

c) The IWCA recommends referencing and following two NGA Glass Technical Papers whether the glass is new or existing
i) FB03-03 Construction Site protection and Maintenance of Architectural Glass
ii) FB01-00 Proper Procedures for Cleaning Architectural Glass Products

Non-Routine Cleaning Tools

1) **Razor blades, scrapers, steel wool, bronze wool, scrub pads:** These are all common tools when engaging in non-routine cleaning. These tools may be used effectively individually or in combination, but greater care must be exercised when selecting and using these tools. Improper selections or misuse of the tools can result in damage to the glass. See FB01-00 Proper Procedures for Cleaning Architectural Glass Products for more information.

a) Scrapers and razor blades: Some material/contaminants can be removed successfully with the proper use of a scraper, but there are many situations where a scraper will not fully or properly address the removal of foreign material. Scrapers come in various sizes, 1.5" – 6" and are available in different gauges (thickness) and composition of blades (carbon steel, stainless steel, ceramic etc.) The blades are available in varying thicknesses, 1.5" blades are available in 9 or 12 gauge. The 9 gauge is .009" thick and the 12 gauge is .012" thick. The only meaningful difference is that the 12 gauge is heavier duty than the 9 gauge. Longer and wider razor blades are available from 3" to 6". These blades are generally available in carbon or stainless steel. Both carbon and stainless-steel blades have high performance when properly used. For window cleaners, the most meaningful difference is that the stainless-steel blades are not as quick to rust. This is important as Ferric Oxide (rust) is harder than glass, and thus a rusty blade can cause scratches on glass.

b) Bronze wool, steel wool, non-scratching scrub pads: These tools/implements are useful in addressing spots, stains, and other foreign materials where a scraper or razor blade may not be effective, advisable, or necessary. If using bronze or steel wool, be sure to choose a grade of coarseness that will not damage the glass. Start with the least coarse grade (OTT) which is 0000 and graduate upward from there. A cautionary note is required here, WOOL HAS THE POTENTIAL TO SCRATCH and each increase in coarseness increases the chance to scratch the glass. If selecting wool, test a small inconspicuous area to determine compatibility with the glass and the chance of damage occurring. Steel wool will not only rust, but it sheds some of its fibers as it is used. If steel wool is used, it becomes important to remove and wash away any of the loose fibers due to the risk of rusting on any surface they may have been deposited on.

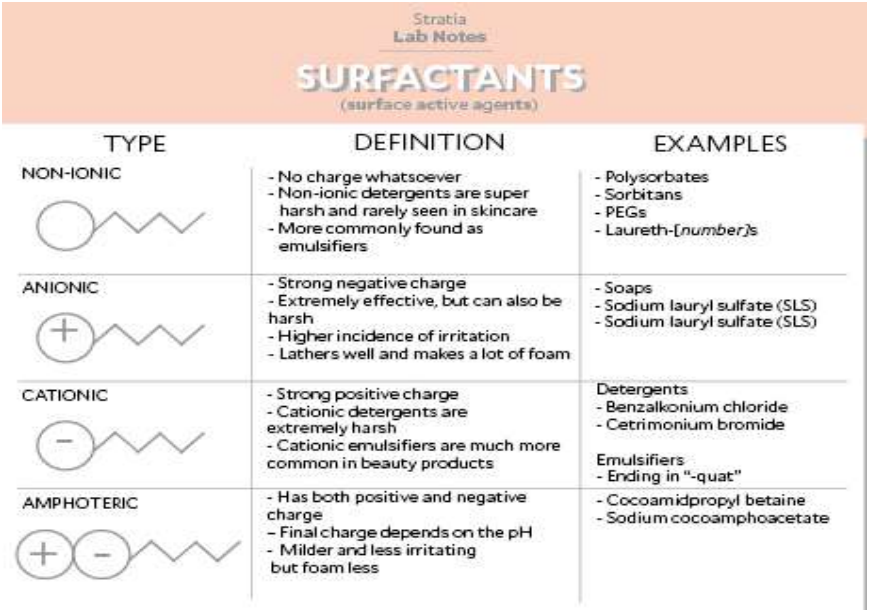
c) Scrub pads: A variety of scrubbing or buffing implements are available to window cleaners. For use in non-routine cleaning, the most often-used scrub pad is the white non-scratching pad. They are available in varying thicknesses depending on what is most applicable or preferred by the user. If the decision is made to use a white scrub pad be certain that the pad chosen is designated as non-scratching and intended for glass. It is recommended to purchase scrub pads from window cleaning supply companies to ensure that they are non damaging to glass.

Cleaning Solvents and Chemicals

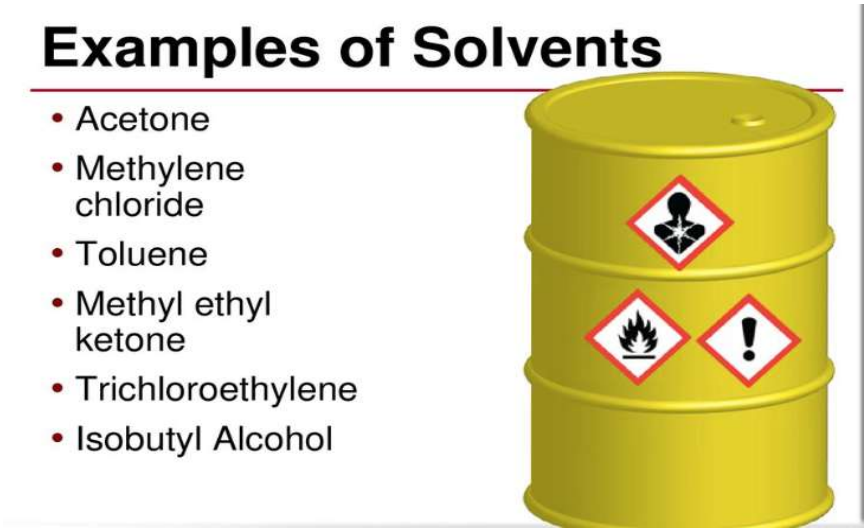
One of the keys to using solvents and chemicals on glass is reading & understanding the label and MSD sheet and following the chemical manufacturer's directions for use. Once the source of the surface issue is identified, it is recommended to perform a small test in an inconspicuous area to confirm effective results and compatibility between the cleaning solution, the glass, and surrounding environment.

1) Understanding cleaning solutions: There are 2 main terms regarding window cleaning solutions.

a) Surfactant: A chemical that surrounds surface contaminants and breaks the molecular bond to the glass.



b) Solvents: Chemicals that also use molecular action to attach and dissolve contaminants.



2) Specialty Chemicals, Acids, Compounds

a) There are various products available on the market that are specifically designed to be effective and safe to use on glass. Some come in liquid form (acids) and are designed to be applied in a controlled manner under trained supervision with all safety protocols in place. The acids are generally applied with a tool such as a strip washer, allowed to "dwell" for a brief time but not allowed to dry, and then removed with a squeegee followed by a rinse to ensure the acids have been cleared from all surfaces around and below the work area.

b) Acids utilized for non-routine cleaning are range in strength from Vinegar, to Phosphoric, Oxalic, Muriatc, to HCL (Hydrochloric Acid) or a combination of HCL and HFL (Hydrofluoric Acid). Most of the previously listed acids, when used properly, are considerably more glass-friendly compared to HFL which is often used to etch glass. Regardless of which acid might be considered, testing is absolutely recommended.

c) Compounds are in the form of pastes and are also applied in a controlled manner. These pastes can contain a mild acid content along with an abrasive to assist in loosening and providing a mechanical scrubbing action to aid in removing any surface contaminants. Pastes can be effective in some non-routine situations, however in many cases if the contaminants have been allowed to accumulate for too long, more aggressive methods may be necessary.

Mechanical Polishing of Glass

In situations where chemical products are not desired, or providing sufficient results in the finished surface, the need to mechanically polish the glass may arise. This is often done with the aid of a polishing machine and can provide a more complete solution to removing surface damage resulting from extended exposure to surface contaminants.

Cerium oxide

Cerium Oxide is a rare earth mineral that has been used for centuries for the purpose of polishing glass. In commercial applications Cerium Oxide presents as a powder that can range in color from orange to white depending on purity and is often milled to an average particle size of ~ 3 micron. As with many products however, Cerium Oxide is available in a range of purities and micron sizes depending on the application and results required. This polishing material can be used to remove minor glass scratches on all glass surfaces. When polishing with Cerium Oxide it is often best to use either natural or synthetic felt and foam polishing pads. Most often Cerium Oxide is simply mixed with water to form either a polishing paste or slurry depending on the application.

Pumice

Pumice, much like other loose abrasives, is available in a myriad of grades depending on application and desired results. Pumice can aid in the rapid removal of surface contaminants that are deposited on the glass and can make quick work of damage from hard water or other salt based build up. FFFF grade Pumice tends to offer the best balance between particle size and hardness for cleaning glass quickly and effectively. While Pumice can remove the vast majority of surface contaminants it may be necessary to follow up Pumice polishing with Cerium Oxide to ensure the final result meets expectations.

Rottenstone

Rottenstone (also known as tripoli powder) is an extremely fine abrasive made from the products of limestone and silica. It's fine grain allows it to be used for polishing many surfaces such as wood, glass, and metal with only minimal lubricant. It is best used after polishing with a slightly less fine abrasive such as pumice, but it can be used on its own with surfaces that are already highly polished.

Glass Surface Issues and Characteristics

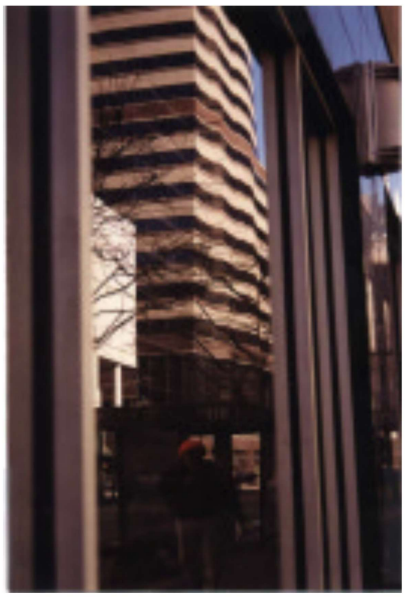
Chemical Stains - Damaged glass through chemical etching has several causes. It could be from hard water stains caused by rain traveling over concrete, spots of water left to dry on windows, or acid rain. Or it could be caused by oxidation, which can happen when metals around windows, such as the screens or window frames, are exposed to rain or humidity and begin to deteriorate. Chemically stained windows may look cloudy, with a white haze that won't wash off, or could appear black or darkened (in cases such as Tin Etch Haze) depending on the reaction between the glass surface and chemical etchant. This prevents you from being able to see clearly through your windows. There are several ways to remove chemical etching from glass depending on the severity and type of etching that has occurred. In some cases this can be done with ease, in others it may require a more comprehensive restoration which can take more complicated methods and time.

Sandblasting and Pitting - Sandblasting is often used to remove surface contaminants from masonry and other building materials that are located in close proximity to glass installed within the building envelope. Often, overspray and other incidental damage to the glass can occur (accidentally) in the process of restoring the building. This damage will present along the spectrum from small pits dispersed across the pane to completely frosted areas of glass.

Other examples of pitting include tile or other aggregates that are cut in close proximity to glass surfaces, spraying remnants onto the glass pitting the surface. This type of damage can be removed only through grinding and polishing the glass surface as there is no chemical or cleaning agent that can restore the surface of the glass back to new.

Roller Wave Distortion - As architectural glass is processed during manufacturing there are a number of times when the glass will be heated to specific critical temperatures that can soften the glass in such a way that the weight of the glass will cause minor “slumping” of the structure upon the surface that is supporting the glass during the thermal cycling process. In almost all cases the glass will be resting or moving on steel rollers which can affect the planar nature of the glass sheet. In these cases the minor slumping of the glass (heating the glass and allowing gravity to pull the material down upon the supporting surface, thus changing the shape of the glass) often occurs while the glass is resting upon the rollers. This will impart slight “waves” or undulations in the surface resulting in what is classified as Roller Wave Distortion.

These minor distortions are frozen into the glass as the glass is cooled and as such will present difficulty in removal depending on the duration of the “slump”. In minor cases this can be removed by resurfacing the glass panel by means of grinding and polishing, however in most cases pronounced Roller Wave Distortion will be beyond what is economically feasible for existing restoration technologies. As such industry standards and performance thresholds are set and maintained within the aforementioned ASTM standards. In the event Roller Wave Distortion is present in the glass, it is imperative that the window cleaner identify this and communicate to the glass owner that this is a permanent feature of the installed pane. Glass thickness and size affect the amount of distortion. Generally, the thicker the glass, the less deviation from flatness while larger glass sizes may also appear to have more distortion.

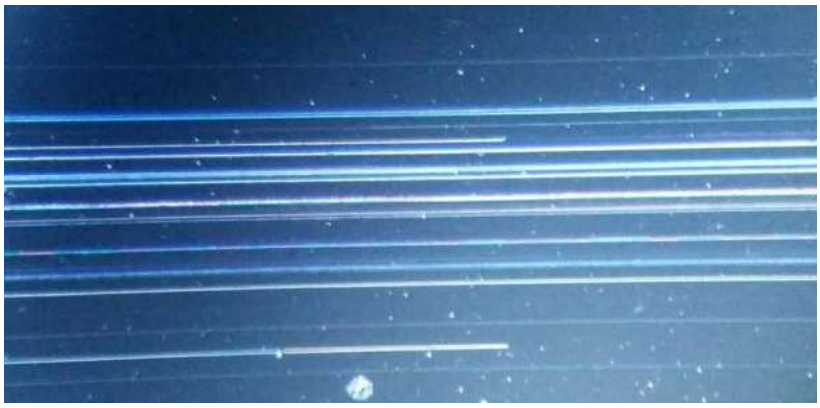


Failed IG Units- IG, or Insulating Glass, units are multiple panes of glass connected through a framework that creates a “dead air” gap between the interior and exterior of the building. During manufacturing, IG units are sealed airtight so as to insure the highest insulation factor possible, given the high degree of thermal conductivity that glass presents. While the dead air is isolated from the surrounding environment, exposure to high thermal variation will, over time, lead to micro expansion and contraction of the air trapped within the IG unit. Over time, this can cause the airtight seal to fail and allow atmospheric air into the space. Depending on relative humidity, air contaminants and other factors present in the surrounding atmosphere, this can lead to the accumulation of dust, debris or condensation within the dead air space in the glazing. Failed IG units most often present as condensation between the panels and will obscure the view through the pane. Once an IG unit has failed, there is no way to fix the unit short of dismantling the glazing, cleaning and reassembling the IG unit. As such, this should be treated as a fatal condition that will require a glass contractor to replace the unit.

Low-E Corrosion - Low-E coatings are produced by a vacuum deposition process called Reactive Magnetron Sputtering (RMS) and are composed of multiple layers. The vast majority of Low-E coatings are applied to the interior surfaces of multi-pane IG Units, most often on Surfaces 2 and 3. In the event of seal failure on these coated IG units, the chemical films can react with contaminants that leak into the IG unit. If coating corrosion due to moisture or adverse chemicals occurs, it will most likely begin at the edge where the silver in the coating stack is exposed. When Low-E Corrosion occurs, as the

damage is within the interior of the IG unit, in almost all cases the glazing will require replacement.

Tics and Fines - In the process of manufacturing glass, large panels of glass are often moved around manufacturing facilities upon steel rollers. Over time the rollers can accumulate dirt and debris that can scratch the side of the glass that is in contact with the rollers. While this is usually abated by frequent cleaning and maintenance of the rollers, instances of infrequent cleaning or insufficient cleaning can lead to surface damage occurring on the panes of glass as they travel over the surface. This surface damage usually presents as small fine scratches and or pits that are pressed into the surface of the glass. While this should not occur to excess, some batches of glass produced while dirty rollers are in play will show a higher occurrence of this type of damage. If found in the field, this type of damage is most often addressed through mechanical grinding and or polishing of the surface.

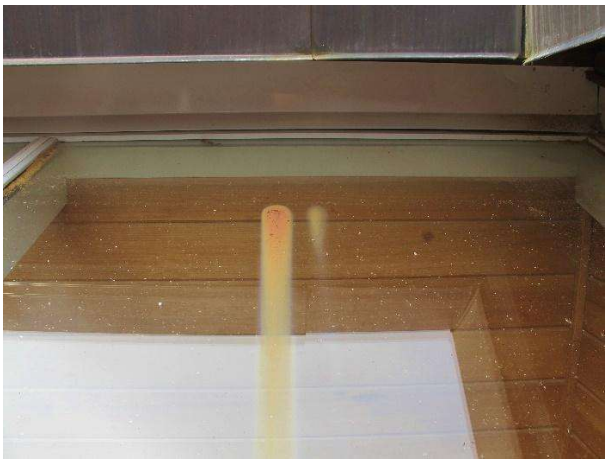


Severe Oxidation / Salt Buildup - While glass is predominantly composed of silicon dioxide, all glass is swimming with a multitude of trace minerals that are embedded throughout the glass material. These trace minerals can and will react with environmental contaminants, and in some cases, can lead to severe oxidation or etching of the glass surface. While the most common source of surface oxidation and etching is exposure to hard water with high concentrations of dissolved salts, traditional hard water stains should not be confused with severe oxidation.

The key difference between what is generally considered to be hard water staining and severe oxidation/etching is that, while hard water stains will present as a surface buildup of salts and

other dissolved solids resolving on the surface, severe oxidation and etching will physically change the surface topography of the glass. This often creates a rough feeling to the surface of the glass with the presence of either an iridescent or solid opaque frosting. Depending on the severity of the damage and the age of the damage, the best methods for resolving this type of surface damage will depend on a myriad of environmental variables. In some cases, a chemical solution will be able to address this type of damage, while in other cases mechanical grinding and polishing will be required.

Metal Oxidation - Depending on the glazing methods employed within, the building envelope the presence of metal framing, both steel and aluminum, can allow for metal oxidation to be deposited on the surface of the glass through normal runoff exposure. These deposits are best removed through regular cleaning and should not be allowed to dwell for prolonged periods of time on the glass. In the event these types of deposits are not removed in a timely manner, they can accumulate over time and present as an iridescent film upon the glass. Often referred to as “screen burn” or metal oxide stains, these will most often require an acidic cleaning agent to dissolve and remove the buildup from the glass surface. In events where acids or other caustic cleaners are incapable of removing the damage, mechanical polishing will be required to restore the glass to clear. As with any cleaning chemical or solution, window cleaners are encouraged to study the potential dangers and hazards associated with the cleaning chemicals being utilized.



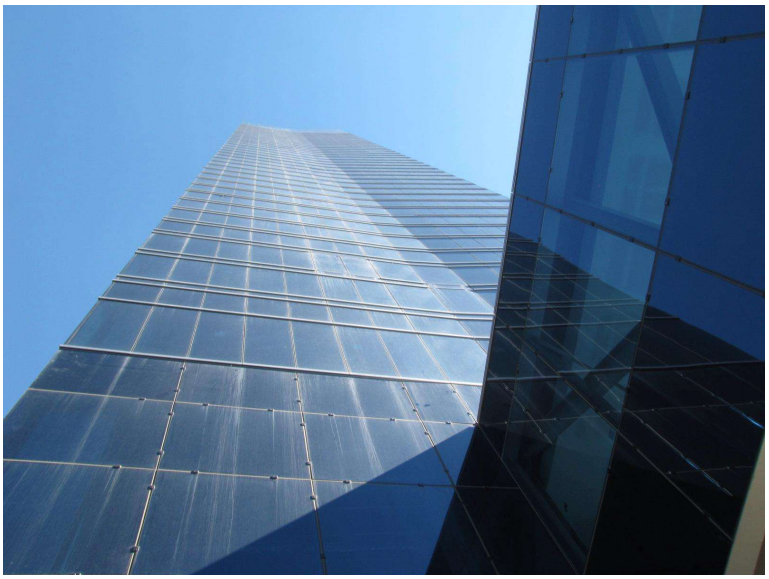
Tin Etch Haze - The vast majority of architectural glass is manufactured through a process that is known as the “Float” process by which molten glass is extruded onto a bath of molten tin. Because the glass is less dense than the tin, the glass will float on the surface of the tin and self-level. This process is used as it helps ensure that the thickness of the glass is uniform across the ribbon (technical term for raw glass exiting the tin bath). While the glass travels across the molten tin bath, the glass begins to cool and take on its crystalline structure. As this occurs small amounts of tin are embedded into the “Tin Side” of the glass. This tin, while invisible to the naked eye, is sitting on the surface of the glass. This tin is very reactive and can oxidize easily when any caustic cleaning agent is used. This oxide appears as a black or deep brown

haze that will cover the area the cleaner was used on. FOR DETAILS ON HOW TO REMOVE THIS DAMAGE, SEE ETCHING REMOVAL SECTION 2.1.2

“Hard Water” Water Spots – Water spots are not necessarily hard water stains. When dirty water dries on the glass, it will leave small particles in the shape of the water droplet on the surface of the glass. Depending on the mineral content/composition of the particles that were left behind, these spots will either wash away with traditional cleaning methods, or a fine outline of the spots will remain after cleaning. In this event, treat the damage as a light etching. FOR DETAILS ON HOW TO REMOVE THIS DAMAGE, SEE ETCHING REMOVAL SECTION 2.1

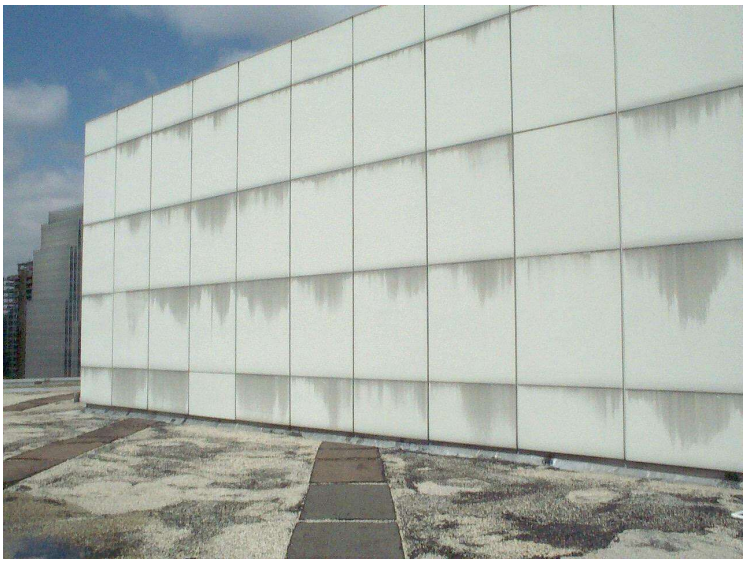
Ghost Suction Cup Marks/Glass Fabrication Processing Marks/Suction Cup Marks - The marks visible on the glass surface are referred to as suction cup marks. They may occur on the glass surface as a result of the manufacturing or installation process. During these processes, suction cups are sometimes used to move the glass. When looking at the surface of any piece of glass on a microscopic level it will not appear as flat, but rather as a rough surface covered with peaks and valleys. The soft rubber on the suction cups that are used to move the glass can leave a light film of rubber on these peaks and valleys giving the glass surface in these areas a slightly hydrophobic characteristic. As such the glass may present as clean and clear, but when condensation or dirt deposits on the surface a “ghost” image of where the suction cups were

used will resolve. In the event suction cup marks present on a job the most effective and often quickest way to remove will be to do a light surface polishing on the affected area.



Building Runoff Stains - The building envelope for any structure (commercial/residential) is going to be composed of many different materials and architectural systems. As the building is exposed to the elements, different envelope materials will react in different ways. Common issues come from rainwater run-off that can leach different compounds and elements from the construction materials. Good examples of this are things like iridescence that can come from leaching metal oxides from the curtain wall system or lye leaching from precast concrete panels. Overall, this type of damage tends to appear as an etched film that runs down the glass. FOR DETAILS ON HOW TO REMOVE THIS DAMAGE, SEE ETCHING REMOVAL SECTION 2.1.2.

Sealant Leaching - Organic sealants used in today's glazing systems may exude, bleed, or leach solvents, oils and/or plasticizers, etc. under normal weathering conditions. Depending on the type of sealant used and the weathering conditions encountered, residue from sealants can vary dramatically in content, degree, and the time period over which the residue continues to exude from the sealant. When the water reaches a building, it is reflected, absorbed into the building materials, or allowed to run down the facade.



When this water is permitted to run down over masonry, sealants, and other building materials, and onto the glass, the water can carry with it contaminants that may react with and adhere to the glass surface. These contaminants could lead to a residue that is difficult to remove, a stain that cannot be removed, or the chemical attachment of certain minerals to the glass surface.

Acid Etch Graffiti - Acid etch graffiti is created using Hydrofluoric Acid to draw on panes of glass. The acid will burn into the glass and physically change the surface structure of the glass so as to refract more light and thus appear frosted or opaque. This type of damage always looks worse than it is, however as with other forms of graffiti, this will require a more aggressive removal technique than more common forms of surface etching.

FOR DETAILS ON HOW TO REMOVE THIS DAMAGE, SEE SCRATCH REMOVAL SECTION 2.3

Scratches

Shallow Surface Scratching

Cleaning Scratches - Many homeowners or property maintenance professionals who are not educated on cleaning glass may opt to try to clean their glass with cleaning agents and chemicals that are not designed to clean and restore the dirty glass. These cleaning agents range from creams with suspended abrasives (ex. Soft Scrub/Ajax/Comet, etc.) to simply cleaning with a Scotch Brite scrubber pad (ex. Green/blue scrubber sponge) that are not designed to clean glass. These materials can be hard enough to leave very fine scratches on the glass that can be seen but not felt. Additionally, some cleaners will loosen surface dirt and contaminants that are in and of themselves hard enough to scratch the surface of the glass, thus as the person cleaning the glass is scrubbing the surface, FOR DETAILS ON HOW TO REMOVE THIS DAMAGE, SEE SCRATCH REMOVAL SECTION 2.3

Debris Scratches - Traditional window cleaning techniques often require the use of a stripwasher or brush to apply cleaning agents to the glass, as well as to provide mechanical scrubbing action to loosen and remove surface contaminants. In some cleaning situations, it is possible for a piece of debris to become lodged in the stripwasher or brush the material in such a way that, unknowingly, the window cleaner inadvertently drags the debris across the glass leaving light surface scratches behind.
FOR DETAILS ON HOW TO REMOVE THIS DAMAGE, SEE SCRATCH REMOVAL SECTION 2.3

Pet Scratches - Pet scratches can be found in any home or building that houses dogs or other pets with nails/claws. In most cases, this will be damage from a dog and be found at/on glass door exits (ex. Sliding glass doors). This damage can range from super fine rub marks to deeper scratches that were caused by debris lodged in the pads of the animal's paw and dragged across the surface of the glass. These scratches are for the most part very fine with the occasional deep gouge. FOR DETAILS ON HOW TO REMOVE THIS DAMAGE, SEE SCRATCH REMOVAL SECTION 2.3

Steel Wool/Rust Scratches - When steel oxidizes (rusts), the resulting oxide compound Fe_2O_3 is able to scratch glass given its hardness rating on the MOHS hardness scale. As such window-cleaning tools that are built with or composed of carbon steel components have the potential to rust. One of the most common cleaning materials that can present an issue is grade 0000 steel wool. Steel wool is traditionally used dry on the surface of the glass to help remove minor organic and inorganic compounds that are not dissolved and cleared away by the cleaning agents. When steel wool gets wet it immediately begins the oxidation process, meaning that in some cases the wool will be extremely rusted in a matter of hours. If rusty steel wool (or any other steel tool such as razor blades) is dragged across the surface of the glass, there is a good chance that the iron oxide will leave fine swirl scratches across that surface. FOR DETAILS ON HOW TO REMOVE THIS DAMAGE, SEE SCRATCH REMOVAL SECTION 2.3

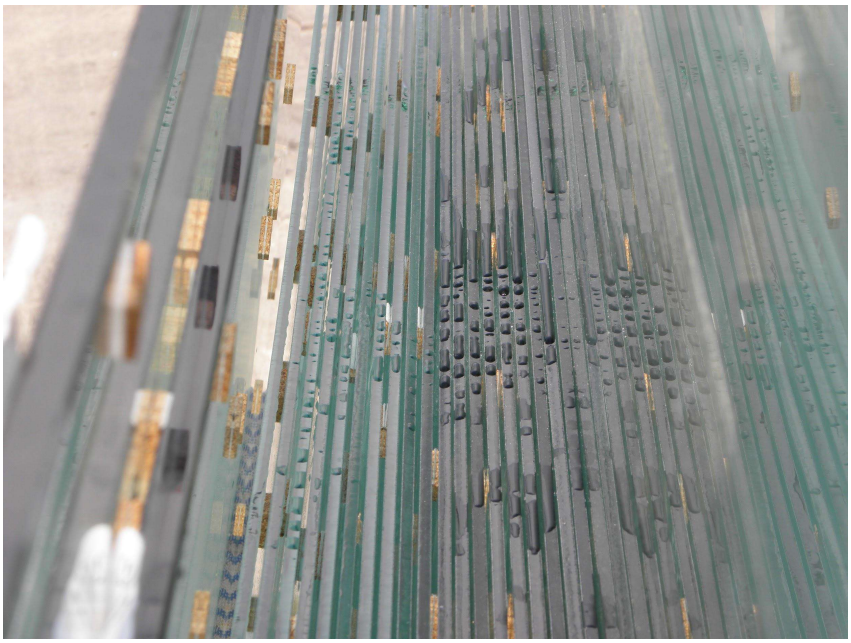
Aluminum Rubs - Many window cleaners will employ the use of ladders to reach high placed panes of glass for cleaning. Most window cleaning ladders are made of aluminum to keep the weight down while ensuring a rigid and stable platform to work from. There is a chance that part of a ladder will rub against the glass, and as glass is harder than aluminum when this happens there is a good chance a small amount of aluminum will be rubbed into the surface of the glass. These rub marks look like scratches with metal that has been inlaid into the scratch cavity. While this damage looks horrible, the damage is often only residual metal that is sitting on the surface of the glass that can be simply polished off. FOR DETAILS ON HOW TO REMOVE THIS DAMAGE, SEE SCRATCH REMOVAL SECTION 2.2.1 Need Photo

Medium-Depth Scratching

Razor Blade Scratches - Traditional window cleaning techniques often employ the use of a razor blade to scrape the surface of the glass to help remove any contaminants from the surface. Sometimes in the process of scraping the glass, particles (dirt or other) will get lodged between the razor blade and the surface of the glass. When this happens there is a chance that the detritus that is dragged across the surface will leave a scratch. While this type of damage has often been referred to as “fabrication debris” more current research on the topic has shown that this type of damage can occur on both Tempered and Annealed glass. FOR DETAILS ON HOW TO REMOVE THIS DAMAGE, SEE SCRATCH REMOVAL SECTION 2.3

Rock/Masonry Damage - While this type of damage will usually fall under either construction cleanup or graffiti damage, there are some instances where the damage will occur outside of these two scenarios. This damage, while generally mild when compared to other forms of construction cleanup or graffiti damage, will be severe enough that damage can be felt with a fingernail and it will be clearly visible from beyond 36 inches. This damage will usually appear as a single piece of damage and most often will not cover the entire pane of glass. FOR DETAILS ON HOW TO REMOVE THIS DAMAGE, SEE SCRATCH REMOVAL SECTION 2.3
Need Photo

Glass on Glass Damage – This type of damage occurs when two pieces of glass scrape or rub against each other. While this is rarely seen in traditional routine fixed-pane cleaning, it is something that can occur regularly when cleaning storm windows. When two pieces of glass rub, a small clear scratch will appear that can be felt with a fingernail and will require more aggressive removal techniques. FOR DETAILS ON HOW TO REMOVE THIS DAMAGE, SEE SCRATCH REMOVAL SECTION 2.3



Severe Scratching (Deep-Depth)

Deep Razor Blade Damage - While most razor blade damage will be light scratches that will follow the path of the razor blade while scraping, occasionally the razor blade will bite into the glass and cut a deep scratch. This scratch will not only catch a fingernail, but it will also exhibit fine chipping along the path of the scratch. These scratches tend to be only a few inches in length, as the window cleaner will quickly realize the scratch is occurring and stop scraping. To remove this type of scratch, it will require a more aggressive removal technique than the previously mentioned routine for razor blade damage. FOR DETAILS ON HOW TO REMOVE THIS DAMAGE, SEE SCRATCH REMOVAL SECTION 2.4

Sandpaper Scratches - Whether employed during construction/remodeling or simply repainting of the exterior, often tradesmen will employ sandpaper to "scuff up" or prepare the surface about to be painted. In cases where windows are composed of wood frames that are to be repainted, there is the chance for incidental sandpaper scratches on the surface of the glass. While this unintentional damage can be sporadic and usually located near the edge of the pane it should be considered severe scratching. FOR DETAILS ON HOW TO REMOVE THIS DAMAGE, SEE SCRATCH REMOVAL SECTION 2.4

SandBlast Damage - Building envelopes that are primarily concrete and masonry will need deep cleaning throughout the life of the building. To do this, most cleaning crews will use some form of media blasting to mechanically remove surface contaminants and debris from the stone/brick/concrete. In some cases, the technicians who are media blasting the surface will overspray onto the glass. Depending on the media used for the blasting, an accidental overspray can cause deep pitting in the glass. This type of damage is one of the deepest and will require the most aggressive removal techniques available. FOR DETAILS ON HOW TO REMOVE THIS DAMAGE, SEE SCRATCH REMOVAL SECTION 2.4

Weld Splatter-

Guide to Glass Surface Restoration

This guide has been put together by the IWCA to provide a basic primer on restoring windows with surface damage. While the vast majority of glass restoration will fall under the umbrella of “non-routine cleaning,” it is important for window cleaners to understand the basic methods and tools needed to restore the damaged glass. This section of the field guide is designed to give a grounding in the basic tools needed to address surface damage on glass, as well as the different restoration methodologies employed.

Window cleaning as a profession is about restoration. Restoring any material by definition means to make it like new. While many window cleaners view window restoration as an activity beyond basic window cleaning, it is important to note that properly cleaning any window will have a restorative effect not only on the pane of glass but also on the building envelope as well. In some cases, the restoration of the pane will go beyond traditional stripwasher and squeegee cleaning techniques and needs to employ other methods and tools. This section of the field guide is here to help identify the types of damage window cleaners will see in the field and provide the information needed to address and restore the damage on site.

While the IWCA will make every effort to keep this field guide up to date with the most current information available, we encourage all those members reading this guide to delve into these topics beyond the field guide to better understand how glass restoration can improve their window cleaning business.

NOTE: THIS SECTION ON GLASS RESTORATION IS DESIGNED TO GIVE THE AVERAGE WINDOW CLEANER A SOLID GROUNDING IN THE CONCEPTS, METHODOLOGIES, AND TYPES OF DAMAGE THEY WILL NEED TO ADDRESS IN THE FIELD. WHILE EVERY EFFORT HAS BEEN MADE TO PROVIDE THE MOST DETAILED INFORMATION AVAILABLE, SOME METHODS WILL NEED FURTHER INSTRUCTIONS FROM TOOL MANUFACTURERS TO INSURE PROPER PERFORMANCE AND ACHIEVED EXPECTED OUTCOMES.

Mechanical Methods for Restoring Damaged Glass

Section 2: Methods for Restoring Damaged Glass

2. Surface Etching Removal Techniques (**NOTE:** THIS SECTION WILL ONLY REVIEW NON-CHEMICAL METHODS FOR REMOVING SURFACE ETCHING FROM GLASS.)

PLEASE NOTE: UNDER "NON-ROUTINE CLEANING" THERE IS A SECTION THAT WILL COVER THE MOST COMMON TYPES OF CLEANING SOLVENTS AND CHEMICALS THAT CAN BE USED TO RESTORE DAMAGED GLASS.

2.1) **Cleaning and scrubbing -** Sometimes there is no substitute for a little elbow grease. When starting with light water spots on the glass that look like they are simply shadows of where spots were left on the glass, these marks can often be buffed off the surface of the glass once the pane has been cleaned. To help make scrubbing more effective, the Glass Cleaner can employ the use of any "non-marking" or "non-scratching" scrubbing tool. These are things like: White Scrub Pads, Bronze Wool, Hogs Hair Brush, or Microfiber Towels. Additionally, the use of abrasive materials along with these scrubbing tools can loosen and remove residual water spots. The general rule-of-thumb is to start with the softest tools and abrasives and build from there.

2.1)1. **Buffing the Glass -** The term "buffing" can be used to cover a lot of different cleaning techniques. For the purpose of removing light surface etching, we will define buffing as using an abrasive material to rub the surface of the glass with an abrasive medium in an effort to dislodge and/or remove surface contaminants. Good examples of this would be to use a white scrubby pad with super fine grade FFFF pumice or Rottenstone. This process is not to be confused with Polishing the glass which will be discussed in the next subsection. This process can be done by hand or with the use of a power sander/polisher. Note that in most cases, when using a power tool to abrade a glass surface, it is critical to employ a tool head that is a DIRECT DRIVE and not a DUAL ACTION or RANDOM ORBIT as random orbit sanders can often leave small squiggly scratches on the surface of the glass, and often will leave trace marks behind. Once it has been determined if the repair will be done by hand or with a power tool, it will then be time to mix the necessary buffing media (pumice/rottenstone/etc.) with clean water (or manufacturer suggested liquid) to form a paste than can be applied to the surface of the buffing material before scrubbing the pane. NOTE: THIS PROCESS CAN SCRATCH THE SURFACE OF THE GLASS IF THE INCORRECT MATERIALS OR PROCESS IS USED.

2.1)2. **Polishing the Glass -** Polishing the glass is different from buffing the glass in that when we are buffing the glass, we are working to remove surface contaminants from the pane of glass. When we are polishing the glass, we are actually making millions of

microscopic cuts into the surface of the glass, making it easier for light to pass through. In effect, polishing can return the glass to perfect clarity. Polishing glass will require both a polishing wheel as well as a polishing compound. While there are many different polishing materials that are used throughout the glass industry and by window cleaners to polish glass, the most common polishing wheels are made of felt or foam and the polishing compound is almost exclusively some form or formula containing cerium oxide. Since the wheels and compounds come in a variety of forms, they can often be confusing to some. When polishing the glass to remove light damage that has resulted from water spotting or light etching in the glass, it is often best to start with as dense of a felt wheel as can be found (these are available from every window cleaning supply company) and a mixture of cerium oxide that is a minimum 70% pure cerium oxide. As a rule of thumb, the purer the cerium, the more expensive it will be, however the purer the cerium the quicker the glass will polish. While there are many variables that determine what type of compound to use, any glass restoration tool manufacturer or window cleaning supply house should be able to offer effective product suggestions. This method will remove light hard water stains, acid rain etching, mild silica staining, and indelible ink and or paint that has been applied to the surface of the glass. NOTE: THIS PROCESS CAN SCRATCH THE SURFACE OF THE GLASS IF THE INCORRECT MATERIALS OR PROCESS IS USED.

2.2) **Light Damage Removal -** For damage that can be seen but not felt with a fingernail, it is best to employ one of the following techniques.

2.2)1. **Polishing the Glass -** Polishing the glass to remove light damage is a little different than when polishing to remove surface etching. Surface etching will tend to cover a large percentage of the glass, requiring in many cases that the window cleaner resurface the majority of the pane. Polishing glass to remove a spot defect is slightly different, in that it will depend on the overall depth of the damage being polished out. To improve chances of success with polish only, make sure to use as dense of a felt wheel as is available in conjunction with the highest purity cerium oxide polishing compound available. These materials are available from every window cleaning supply company and are manufactured by a number of glass restoration tool manufacturers. This method can be successful in removing surface scratch damage from Scotch Brite Pads and other mild abrasive cleaning agents and materials used in most homes and businesses, as well as damage from metallic rubs, mild glass on glass rubs, most pet scratches, and other light damage that cannot be felt with a fingernail. NOTE: THIS PROCESS CAN SCRATCH THE SURFACE OF THE GLASS IF THE INCORRECT MATERIALS OR PROCESS IS USED.

2.3) **Scratches/Acid Graffiti -** Scratches in glass can range from light to severe, and in every case are going to be removed by either polishing or abrading the surface of the glass followed by polishing.

2.3)1. **Grinding/Sanding the Glass -** There are a number of tool systems available on the market that will allow a window cleaner to remove deeper damage from a pane of glass

by grinding and polishing the glass. While there are a number of different tool manufacturers utilizing myriad technologies, all of the systems use one of two methodologies: either a wet method utilizing water or a dry method, without water. Both types of systems offer different advantages and challenges, however, for architectural glass, dry systems tend to out-perform wet systems with regards to speed, cleanliness, and, of course, final result. Both methods are simple in concept but do require a firm grasp and understanding of the tools and processes that are employed. Because this type of restoration falls outside of what is normally considered routine cleaning, it is important that window cleaners independently research and explore the different systems available. The dry method of glass restoration will be able to remove all types of surface damage on glass, ranging from hard water stains to deep scratch tag graffiti and everything in-between, quickly and generally with a better end result. It is important to view this method of glass restoration as a “RESET” button for the pane, as this process will refresh the damaged area by removing the top layers of glass and exposing virgin glass from within the pane. For more information about the different glass restoration tool systems available today, contact any window-cleaning supplier or refer to the IWCA.

2.4) **Extreme Damage -** Damage from welding slag and media blasting are considered the most severe types of damage that can be inflicted on a pane of glass. These types of damage travel deep into the core of the pane and can take more time and effort to remove. The process for removing this type of damage will require more aggressive abrasives and the same grinding/sanding-the-glass methodology listed above in section 2.3.1.

Irreparable Damage

Damage that would be considered beyond repair (no way to repair at all):

- Cracks / Chips or other structural failures
- Deep Welding Splatter (burn beyond 50% of the way through the glass)
- Extreme Media Blasting Damage (this can be removed but it is often more expensive than replacing)

Other than those exceptions, there are chemical and mechanical solutions to restore just about everything else.

Glass Technical Papers

Excerpt from NGA/IWCA FB01-00 **"Proper Procedures for Cleaning Architectural Glass Products"**

Architectural glass products play a major role in the comfort of the living and working environment of today's homes and commercial office spaces by providing natural daylight, views of the surroundings, thermal comfort, and design aesthetics. Glass usage and condition often affect our selection of where we live, work, shop, play and seek education.
This document describes procedures that generally apply to most architectural glass products. Certain glass types may require different procedures and care. Glass can be clear or tinted, and have pyrolytic or sputtered Low-E or reflective coatings, some of which may be on the exposed surface of the glass. Glass products can be monolithic (single-lites), laminated glass or insulating glass units. NGA Glass Technical Paper FB15-07 "Describing Architectural Glass Construction". Glass can be of various strengths, i.e., annealed, heat-strengthened, or fully tempered. There are also other decorative and functional glass types including spandrel, silk-screened, patterned, acid etch, and sand-blasted.
Architectural glass products should be properly cleaned and protected throughout the construction process using a program of regularly scheduled maintenance designed to maintain visual clarity and prevent glass surface damage. Since glass products can be permanently damaged if infrequently or improperly cleaned, glass producers and fabricators recommend strict compliance with the following procedures for cleaning glass surfaces. Read the full Glass Technical Paper here:
https://members.glass.org/cvweb/cgi-bin/msascartdll.dll/ProductInfo?productcd=PROPERPROCEDURES

Excerpt from NGA/IWCA Glass Technical Paper FB03-03 "Construction Site Protection and Maintenance of Architectural Glass"
Architectural glass products used in windows, doors, and skylights for today's residential and commercial building projects are more sophisticated than those used in earlier fenestration applications. Performance requirements call for glass to be coated and used in an insulating glass unit in order to be more energy efficient; and often heat-treated and laminated to provide greater strength, safety and security. As a result of increased performance capabilities, more high-performance glass is being used in both residential and commercial construction. The higher valued products and their greater susceptibility to damage have increased the importance of proper site storage, handling, installation, and protection throughout the construction process. During glass manufacturing, fabrication, and installation, products are carefully handled to prevent surface and edge damage. Materials are packaged to provide protection during shipment and delivery. Once finished materials are placed on a construction site, they become exposed to a variety of conditions and influences that can adversely affect product aesthetics and functionality. Irreparable glass damage can occur from improper storage and handling, exposure to chemicals and leaching agents, prolonged exposure to moisture,

mechanical attack and breakage, damage related to adjacent construction activities, and improper cleaning methods. Read the full Glass Technical Paper here: https://members.glass.org/cvweb/cgi-bin/msascartdll.dll/ProductInfo?productcd=CONSTRUCTIONSITE

Related Resources:

NGA Glass Technical Paper FB15-07 Describing Architectural Glass Constructions
https://members.glass.org/cvweb/cgi-bin/msascartdll.dll/ProductInfo?productcd=GLASSCONSTRUCTIONS

NGA Glass Technical Paper FB02-02 *Heat-Treated Glass Surfaces are Different*:
https://members.glass.org/cvweb/cgi-bin/msascartdll.dll/ProductInfo?productcd=HEATTREATEDGLASS

NGA Glass Technical Paper FB19-08 *Guidelines for Handling and Cleaning Decorative Glass*:
https://members.glass.org/cvweb/cgi-bin/msascartdll.dll/ProductInfo?productcd=HANDLINGANDCLEAN

NGA Glass Technical Paper FB06-05 *Proper Procedures for Cleaning Flat Glass Mirrors*:
https://members.glass.org/cvweb/cgi-bin/msascartdll.dll/ProductInfo?productcd=PROCEDURESCLEANING

NGA Glass Technical Paper FM02-09 *Protecting Glass Against Weld Splatter*:
https://members.glass.org/cvweb/cgi-bin/msascartdll.dll/ProductInfo?productcd=WELDSPLATTER

Glass Standards

Surface Issues Standards

ASTM International, formerly known as American Society for Testing and Materials, is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services.

Understanding the Standards

ASTM International is the basis for understanding glass and coating quality, allowable defects, and visual inspection criteria. ASTM has many different specifications and classifications depending on the type of glass being analyzed or quality controlled. Some examples of quality criteria are:

1. ASTM C1036–Standard Specification for Flat Glass
2. ASTM C1048–Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
3. ASTM C1172–Standard Specification for Laminated Architectural Flat Glass

Definitions

Restoration Definitions

Building Envelope - The exterior surface of a building

Glass - SiO_2 based glass manufactured and used for architectural purposes

Plate Glass - A large single plane of annealed glass

Annealed Glass - Raw Glass that has had no structural processing, also known as float glass

Tempered Glass - Glass that has been structurally processed so as to increase the strength and durability of the glass while also improving the safety of the glass with respect to breakage

Low E Glass - A pane of glass that has undergone a coating process so as to improve the insulation properties of a window system by limiting infrared and UV light

Tinting (Film) - A plastic semi-translucent film that is affixed to the surface of a pane in an effort to restrict the amount of light transmitted into the building

Pane - A single plane of glass usually installed into a window system, also called a “lite” of glass

Window - A framed piece of glass that is installed into a building envelope

Storm Window - A pane of glass that is not permanently attached to the window system used to improve the insulation properties of the building envelope

Vinyl Windows - A window system that uses vinyl extrusion for the frame

Insulating Glass Unit (IGU) - An assembly of two or more of glass configured so as to create a “dead air” space within the window system for the purpose of increasing the insulation factor of the building envelope. Modern IG units are filled with inert noble gasses to further improve the insulation factor for the unit

Stain - A visible mark on a surface that has penetrated the surface so as to remain after cleaning the surface in a routine manner

Etch - A visible mark on a surface where surface material has been eroded away so as to change the surface structure and integrity

Scratch - A visible, often linear cut in a surface whereby the surface material is scraped and/or gouged out of the surface

Tin Etch Haze - A visible black semi-translucent stain occurring when an acidic cleaning solvent/agent especially HF (Hydro Floric acid) is applied to the Tin side of the glass

Hard Water Stains - A visible mark on a surface that has come in repeated/consistent contact with water containing a high level of reactive dissolved solids

Razor Scratches - A scratch that is created by a razor blade during traditional cleaning

Graffiti - An unauthorized visible mark on a surface, usually vandalism

Scratch Tag Graffiti - A visible scratch, often very deep, that has been cut/gouged into a window

Acid Etch Graffiti - Drawing/writing on glass with hydrofluoric acid so as to etch the message into the glass permanently

Cerium Oxide - Rare earth mineral used to polish silica-based glass

Bronze Wool - Spun bronze wire often used to scrub glass since, bronze won't rust

Buffing - Using, abrasive material to remove surface dirt or contaminants from the pane of glass

Polishing - Using an abrasive material and/or an abrasive compound to remove the top layer of surface

Water Spots - Unlike Hard Water Stains, water spots are often just dirt left on the window from evaporating water

Smoked Windows - This can refer to either:

1. Tin Etch Haze – (See Above)
2. Tinted glass (Chemically tinted glass, not film tint)
3. Failed IG Units

Fabrication Debris - While this phrase can be found beyond this guide, it is important to note that recent research has shown that previous definitions of fabrication debris were incorrect, and thus, the phrase is no longer used. Fabrication debris was originally thought to be a small particulate matter that accumulates on the surface of the glass that is being tempered, transferred to the glass via the rollers within the tempering oven that the glass is moved on. Subsequent exhaustive research in part funded by the IWCA and glass

manufacturers and carried out at the Penn State Material Sciences Laboratory have failed to produce, reproduce, identify in field samples and batch samples the presence of “fabricating debris”

Quick-Reference Guide to Cleaning Architectural Glass Products

The following “Do’s” and “Don’ts” are offered as a supplement to the NGA/IWCA FB01-00 “Proper Procedures for Cleaning Architectural Glass Products”: The following are things to DO:

- DO clean glass when dirt and residue appear
- DO protect glass, during all stages of construction
- DO determine if coated glass surfaces are exposed
- DO exercise special care when cleaning coated glass surfaces
- DO avoid cleaning tinted and coated glass surfaces in direct sunlight
- DO start cleaning at the top of the building and continue to lower levels
- DO soak the glass surface with a clean water and soap solution to loosen dirt and debris
- DO use a mild, non-abrasive commercial window cleaning solution
- DO use a window-cleaning squeegee to remove all of the cleaning solution.
- DO clean one representative window and check to see if procedures have caused any damage
- DO be aware of and follow the glass supplier’s specific cleaning recommendations
- DO caution other trades against allowing other materials to contact the glass
- DO watch for and prevent conditions that can damage the glass
- DO read the following Glass Technical Papers (GTPs) before cleaning any heat-strengthened or tempered glass products: • FB15-07 Describing Architectural Glass Constructions • FB02-02 Heat-Treated Glass Surfaces Are Different. • FB03-03 Construction Site Protection and Maintenance of Architectural Glass (in collaboration with IWCA) • FB01-00 Proper Procedures for Cleaning Architectural Glass Products

The following are things NOT to do:

- DO NOT start cleaning without reading: • FB15-07 Describing Architectural Glass Constructions • FB02-02 Heat-Treated Glass Surfaces Are Different. • FB03-03 Construction Site Protection and Maintenance of Architectural Glass (in collaboration with IWCA) • FB01-00 Proper Procedures for Cleaning Architectural Glass Products
- DO NOT allow dirt and residue to remain on glass for an extended period of time
- DO NOT begin cleaning glass without knowing if a coated surface is exposed
- DO NOT clean tinted or coated glass in direct sunlight
- DO NOT allow water or cleaning residue to remain on the glass or adjacent materials
- DO NOT begin cleaning without rinsing excessive dirt and debris

- DO NOT use abrasive cleaning solutions or materials for maintenance cleaning
- DO NOT ever use razor blades on coated glass surfaces
- DO NOT allow metal parts of cleaning equipment to contact the glass
- DO NOT trap abrasive particles between the cleaning materials and the glass surface
- DO NOT allow other trades to lean tools or materials against the glass surface
- DO NOT allow splashed materials to dry on the glass surface

Consult either www.glass.org/store or www.iwca.org for additional information and links providing additional technical resources. The National Glass Association has produced this Glass Information Bulletin in cooperation with the International Window Cleaning Association (IWCA) solely to provide general information as to basic proper procedures for cleaning architectural glass products. The Bulletin does not purport to state that any one particular type of glass cleaning process or procedure should be used in all applications, or even in any specific application. The user of this Bulletin has the responsibility to ensure the cleaning instructions from the glass supplier are followed. National Glass Association disclaims any responsibility for any specific results relating to the use of this Bulletin, for any errors or omissions contained in the Bulletin, and for any liability for loss or damage of any kind arising out of the use of this Bulletin.[KW1]

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Quick Reference

Supporting Documents