PROTECTING FLAT GLASS SURFACES
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Flat glass must be protected during shipment and storage. Only by proper handling and storage techniques can the integrity and clarity of the glass be assured before installation (see ATS-112 - "Preventing Moisture Stains on Stored Glass"). After installation, appropriate precautions and proper maintenance are needed for long and trouble free service. **In this bulletin we will explore the various causes of glass surface damage, means of prevention, and methods of identification and removal of stains.** The specific cause of glass surface damage can be difficult to diagnose, and stain removal is usually costly. Therefore, prevention of such damage is better than any "cure." To prevent glass surface damage, follow the procedures for storage, installation, and maintenance that are recommended below.

CAUSES OF GLASS SURFACE DAMAGE

Water Attack:
Once installed, glass can withstand large amounts of water without significant surface damage. However, water can accumulate when there is inadequate separation between lites in storage. Even small amounts of water trapped in this way can cause surface deterioration. Glass in contact with water enters into a series of complex chemical reactions, which result in alkaline solutions. The trapped water reacts slowly initially, but in time the reaction accelerates, resulting in a rapidly increasing alkali concentration. The alkaline solution attacks the glass surface by dissolving away surface ingredients (sodium) which results in hazing and roughness. Initial attack may cause only a faint whitening of the glass surface due to the change from a glassy silicate structure to a crystalline silicate structure. At this stage, a light polishing or special chemical treatment would probably restore the glass surface. However, the condition worsens in time and the final stages of attack result in decomposition and deterioration of the appearance of the glass surface.

Chemical Air Pollutants:
Certain chemicals can also deteriorate glass surfaces. While glass is resistant to most acids, even dilute forms of hydrofluoric and phosphoric acids quickly react with silica in glass. A variety of other chemicals can also attack glass surfaces. These substances are transmitted in airborne sprays and mists. They can be carried for some distances, not only in industrial, but also in rural and residential areas. Even solid particulates can break down into destructive compounds when held against glass surfaces by water condensation. Even water alone can be a surface damaging agent of glass. Certain types of hard water, for instance, may leave harmful deposits if allowed to dry on glass surfaces. These deposits can be formed in washing or rinsing the glass, or accidentally by the evaporation of water from such sources as lawn sprinklers. **It is difficult or impossible to remove such residue without excessive polishing.**

Alkali Attack:
Building materials and construction methods can cause surface damage to glass. A very common cause of such problems is alkalis being leached from precast concrete panels by rain, or fluorides in the washoff from concrete floors. These materials will stain or etch the glass if allowed to remain for a few days. When this occurs, there is no practical method of restoring the glass surface. Other sources of damaging alkalis are some lubricants used during installation of neoprene structural gaskets and locking strips. When using lubricants for such installations, avoid those containing high levels of alkaline ingredients. The gasket manufacturer should recommend a suitable lubricant. Potentially harmful alkalis are also sometimes

present in marking materials used on glass installations during construction. Such markings are, of course, useful in making the glass more visible, thus reducing accidental breakage. However, the marking materials may stain the glass if they contain alkalis, or if water vapor is allowed to condense on them.

Physical Damage:
Glass surfaces can be altered by physical abrasion such as scratches, rub marks and many different types of deposits. These can come during handling, installation, and storage. Such damage may be similar in appearance to chemical deterioration, however, the difference can be determined under microscopic examination and various stain removal tests. **Further surface damage is accelerated by abraded glass because any moisture present produces strongly alkaline solutions which attack the glass.** On a job site, the welding of metal lose to window areas is often necessary and results in sparks which can damage unprotected glass surfaces. The welding sparks which come in contact with the glass surface cause a thermal shock, which results in a pitting of the surface of the glass. As well as detracting from the appearance of the glass, this pitting reduces the strength of the glass. The reduction in glass strength may have little relationship to the size of the pits since a smaller pit may have vents originating from it which are not visible to the naked eye. In comparison, a much larger pit may only be a harmless smooth spall. A microscopic examination of each pit would be necessary to determine the effect on the glass. Even with such a precise unrealistic examination, such a judgment would only be speculative. Metals that oxidize, weathering steel for example, can leave a stain on the glass which is difficult to remove. This oxidation of the steel stabilizes over a period of time, depending on frequency of rainfall and other climatic conditions. However, the washoff from the steel during the initial oxidation can leave a residue of rust (iron oxide) on adjacent materials including glass. It may be difficult to remove this residue from the glass if it is allowed to accumulate.

PROTECTION OF GLASS SURFACES

Storage:
To prevent glass surface deterioration, water and chemicals should not be allowed to dry on the glass. This is especially important in storage. Storage areas for glass should be maintained at temperatures and humidities that will prevent water vapor condensation on the glass. Glass should be stored at a nearly constant temperature above the dew point. The relative humidity should always be held less than 80. On a job site, glass should be stored inside the building and should be protected from driving rain. Outdoor storage is always risky because of the strong chance of moisture condensation. Periods of outdoor storage should be kept minimal. Glass subjected to cyclic wetting and drying during storage can become stained or etched. This condition can occur during storage at a job site, warehouse, or a customer's cutting area even while the glass is still in the shipping case. Glass stored out of the case should always be stored with interleaving or spacing between individual lites of glass.
Also, it is a good practice for the glazing contractor to caution the general contractor concerning glass surface damage from welding sparks. The general contractor should make sure that all necessary precautions are followed by subcontractors. For more information on storing glass, refer to LOF technical information ATS-112 - "Preventing Moisture Stains on Stored Glass." Protection of glass on the job site is usually the responsibility of the general contractor. Therefore, it is a good practice for the glazing contractor to advise him that the glass should be washed during and after constructionT'or until alkalis are no longer leached from other building materials

Proper Cleaning of Glass:
Glass should be cleaned with a soft, clean, grit-free cloth and a mild, non- abrasive, non-alkaline cleaning solution. The glass should be rinsed immediately with clean rinse water, and excess rinse water should be removed promptly with a squeegee. Grease and glazing materials should be removed

with xylene or toluene, followed by normal washing and rinsing. For proper instructions on cleaning ECLIPSE® Reflective glass and Mirropane E.P.® transparent mirror glass, refer to LOF Technical Bulletin ATS-117 - "Washing of ECLIPSE Products." **For glass which exhibits a stain, either iridescent or whitish, other cleaning procedures can be used such as the patented LOF buffered acid solution or cerium oxide blocking. Materials, such as volcanic pumice, that scratch the surface of the glass should not be used**.

In the case of stained glass problems, a sample of the damaged glass may be sent to the Architectural Technical Service Department of Libbey-Owens-Ford Co. As a service to our customers and to the users of our glass products, we analyzetuch samples and subject them to a number of removal processes. Our technicians determine:
If the stain can be removed.
Which stain removal process is most effective.

Stain removal is time consuming and costly. Again, we stress that the original xntegrity and surface quality of LOF glass products is best maintained by proper storage, handling, installation, and maintenance before damage occurs. if you have problems, however, we are at your service.

The information contained in this and other **Libbey-Owens-Ford Co.** publications is offered for your assistance in the application of LOF flat glass products, but DOES NOT CONSTITUTE A WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. Actual performance may vary in particular applications. **You should contact the Libbey-Owens-Ford Co. Architectural Services Department -- concerning particular product applications**.