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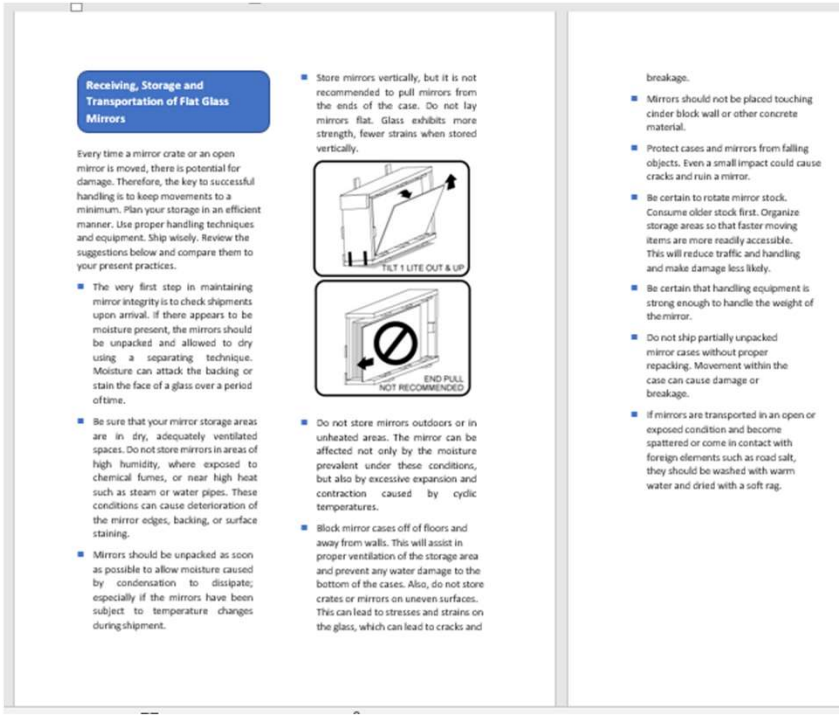
NGA GLASS CONFERENCE™
CHICAGO — JULY 18-20, 2022

MIRROR DESIGN GUIDE

Use portions of existing Glass Technical Papers to create the Mirror Design Guide

Sections of the Mirror Design Guide

1. Installation, care, and cleaning of flat glass mirrors
2. Receiving, handling, and fabrication of flat glass mirrors
3. Construction site conditions
4. Understanding distortion
5. Transparent mirror products
6. Sustainability



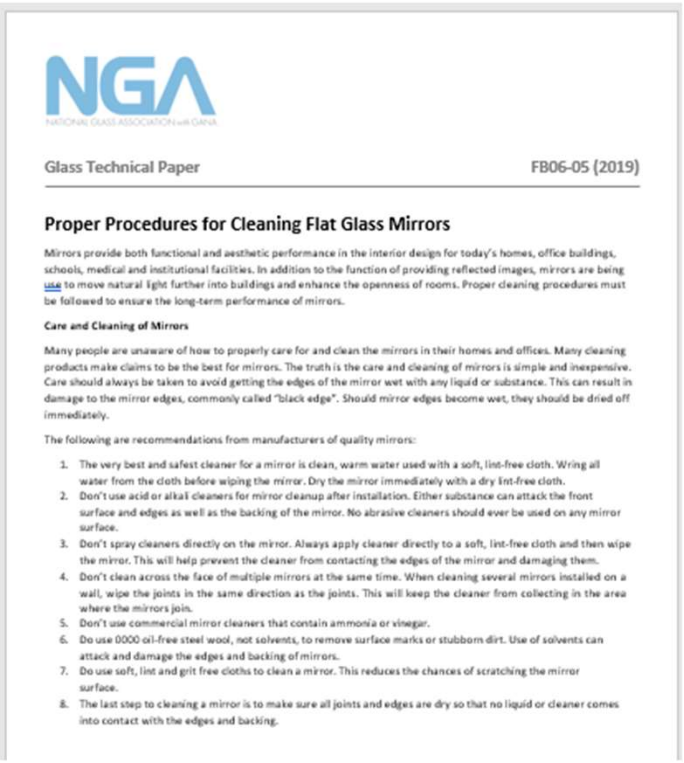
Receiving, Storage and Transportation of Flat Glass Mirrors

Every time a mirror crate or an open mirror is moved, there is potential for damage. Therefore, the key to successful handling is to keep movements to a minimum. Plan your storage in an efficient manner. Use proper handling techniques and equipment. Ship wisely. Review the suggestions below and compare them to your present practices.

- The very first step in maintaining mirror integrity is to check shipments upon arrival. If there appears to be moisture present, the mirrors should be unpacked and allowed to dry using a separating technique. Moisture can attack the backing or stain the face of a glass over a period of time.
- Be sure that your mirror storage areas are in dry, adequately ventilated spaces. Do not store mirrors in areas of high humidity, where exposed to chemical fumes, or near high heat such as steam or water pipes. These conditions can cause deterioration of the mirror edges, backing, or surface staining.
- Mirrors should be unpacked as soon as possible to allow moisture caused by condensation to dissipate; especially if the mirrors have been subject to temperature changes during shipment.
- Store mirrors vertically, but it is not recommended to pull mirrors from the ends of the case. Do not lay mirrors flat. Glass exhibits more strength, fewer strains when stored vertically.

- Do not store mirrors outdoors or in unheated areas. The mirror can be affected not only by the moisture prevalent under these conditions, but also by excessive expansion and contraction caused by cyclic temperatures.
- Block mirror cases off of floors and away from walls. This will assist in proper ventilation of the storage area and prevent any water damage to the bottom of the cases. Also, do not store crates or mirrors on uneven surfaces. This can lead to stresses and strains on the glass, which can lead to cracks and breakage.
- Mirrors should not be placed touching cinder block wall or other concrete material.
- Protect cases and mirrors from falling objects. Even a small impact could cause cracks and ruin a mirror.
- Be certain to rotate mirror stock. Consume older stock first. Organize storage areas so that faster moving items are more readily accessible. This will reduce traffic and handling and make damage less likely.
- Be certain that handling equipment is strong enough to handle the weight of the mirror.
- Do not ship partially unpacked mirror cases without proper repacking. Movement within the case can cause damage or breakage.
- If mirrors are transported in an open or exposed condition and become spattered or come in contact with foreign elements such as road salt, they should be washed with warm water and dried with a soft rag.

MIRROR DESIGN GUIDE



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Glass Technical Paper FB06-05 (2019)

Proper Procedures for Cleaning Flat Glass Mirrors

Mirrors provide both functional and aesthetic performance in the interior design for today's homes, office buildings, schools, medical and institutional facilities. In addition to the function of providing reflected images, mirrors are being use to move natural light further into buildings and enhance the openness of rooms. Proper cleaning procedures must be followed to ensure the long-term performance of mirrors.

Care and Cleaning of Mirrors

Many people are unaware of how to properly care for and clean the mirrors in their homes and offices. Many cleaning products make claims to be the best for mirrors. The truth is the care and cleaning of mirrors is simple and inexpensive. Care should always be taken to avoid getting the edges of the mirror wet with any liquid or substance. This can result in damage to the mirror edges, commonly called "black edge". Should mirror edges become wet, they should be dried off immediately.

The following are recommendations from manufacturers of quality mirrors:

1. The very best and safest cleaner for a mirror is clean, warm water used with a soft, lint-free cloth. Wring all water from the cloth before wiping the mirror. Dry the mirror immediately with a dry lint-free cloth.
2. Don't use acid or alkali cleaners for mirror cleanup after installation. Either substance can attack the front surface and edges as well as the backing of the mirror. No abrasive cleaners should ever be used on any mirror surface.
3. Don't spray cleaners directly on the mirror. Always apply cleaner directly to a soft, lint-free cloth and then wipe the mirror. This will help prevent the cleaner from contacting the edges of the mirror and damaging them.
4. Don't clean across the face of multiple mirrors at the same time. When cleaning several mirrors installed on a wall, wipe the joints in the same direction as the joints. This will keep the cleaner from collecting in the area where the mirrors join.
5. Don't use commercial mirror cleaners that contain ammonia or vinegar.
6. Do use 0000 oil-free steel wool, not solvents, to remove surface marks or stubborn dirt. Use of solvents can attack and damage the edges and backing of mirrors.
7. Do use soft, lint and grit free cloths to clean a mirror. This reduces the chances of scratching the mirror surface.
8. The last step to cleaning a mirror is to make sure all joints and edges are dry so that no liquid or cleaner comes into contact with the edges and backing.

Installation, care, and cleaning of flat glass mirrors

1. Installation Techniques Designed to Prolong the Life of Flat Glass Mirrors
2. Proper Procedures for Cleaning Flat Glass Mirrors

Receiving, handling, and fabrication of flat glass mirrors

1. Proper Procedures for Receiving, Storage, and Transportation of Flat Glass Mirrors
2. Proper Procedures for Fabrication of Flat Glass Mirrors

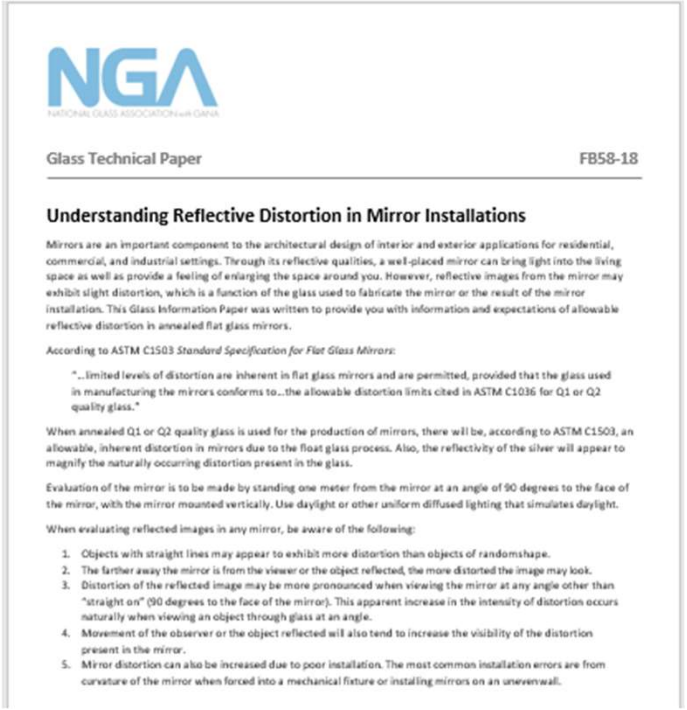
MIRROR DESIGN GUIDE

Construction site conditions

1. Construction Site protection and Maintenance of Architectural Glass

Understanding distortion

1. Understanding Reflective Distortion in Mirror



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Glass Technical Paper FB58-18

Understanding Reflective Distortion in Mirror Installations

Mirrors are an important component to the architectural design of interior and exterior applications for residential, commercial, and industrial settings. Through its reflective qualities, a well-placed mirror can bring light into the living space as well as provide a feeling of enlarging the space around you. However, reflective images from the mirror may exhibit slight distortion, which is a function of the glass used to fabricate the mirror or the result of the mirror installation. This Glass Information Paper was written to provide you with information and expectations of allowable reflective distortion in annealed flat glass mirrors.

According to ASTM C1503 *Standard Specification for Flat Glass Mirrors*:

> "...limited levels of distortion are inherent in flat glass mirrors and are permitted, provided that the glass used in manufacturing the mirrors conforms to...the allowable distortion limits cited in ASTM C1036 for Q1 or Q2 quality glass."

When annealed Q1 or Q2 quality glass is used for the production of mirrors, there will be, according to ASTM C1503, an allowable, inherent distortion in mirrors due to the float glass process. Also, the reflectivity of the silver will appear to magnify the naturally occurring distortion present in the glass.

Evaluation of the mirror is to be made by standing one meter from the mirror at an angle of 90 degrees to the face of the mirror, with the mirror mounted vertically. Use daylight or other uniform diffused lighting that simulates daylight.

When evaluating reflected images in any mirror, be aware of the following:

1. Objects with straight lines may appear to exhibit more distortion than objects of randomshape.
2. The farther away the mirror is from the viewer or the object reflected, the more distorted the image may look.
3. Distortion of the reflected image may be more pronounced when viewing the mirror at any angle other than "straight on" (90 degrees to the face of the mirror). This apparent increase in the intensity of distortion occurs naturally when viewing an object through glass at an angle.
4. Movement of the observer or the object reflected will also tend to increase the visibility of the distortion present in the mirror.
5. Mirror distortion can also be increased due to poor installation. The most common installation errors are from curvature of the mirror when forced into a mechanical fixture or installing mirrors on an uneventwall.

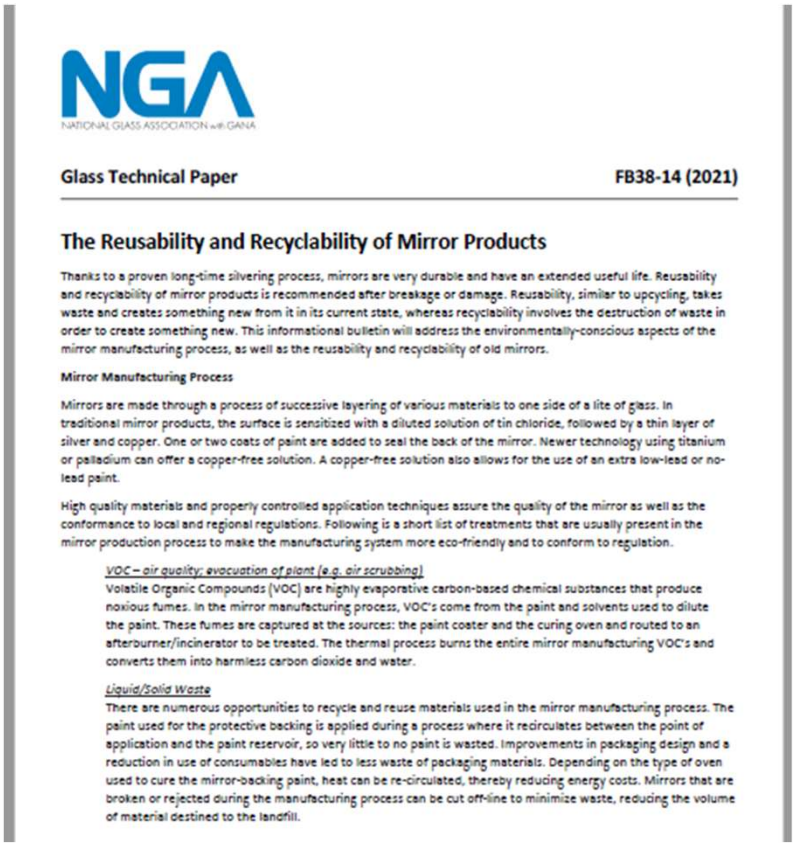
MIRROR DESIGN GUIDE

Transparent mirror products

Sustainability

1. The Reusability and Recyclability of Mirror Products

*Call for photos of fabrication, inspection, installation and completed projects with mirror



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Glass Technical Paper **FB38-14 (2021)**

The Reusability and Recyclability of Mirror Products

Thanks to a proven long-time silvering process, mirrors are very durable and have an extended useful life. Reusability and recyclability of mirror products is recommended after breakage or damage. Reusability, similar to upcycling, takes waste and creates something new from it in its current state, whereas recyclability involves the destruction of waste in order to create something new. This informational bulletin will address the environmentally-conscious aspects of the mirror manufacturing process, as well as the reusability and recyclability of old mirrors.

Mirror Manufacturing Process

Mirrors are made through a process of successive layering of various materials to one side of a lite of glass. In traditional mirror products, the surface is sensitized with a diluted solution of tin chloride, followed by a thin layer of silver and copper. One or two coats of paint are added to seal the back of the mirror. Newer technology using titanium or palladium can offer a copper-free solution. A copper-free solution also allows for the use of an extra low-lead or no-lead paint.

High quality materials and properly controlled application techniques assure the quality of the mirror as well as the conformance to local and regional regulations. Following is a short list of treatments that are usually present in the mirror production process to make the manufacturing system more eco-friendly and to conform to regulation.

VOC – air quality; evacuation of plant (e.g. air scrubbing)
Volatile Organic Compounds (VOC) are highly evaporative carbon-based chemical substances that produce noxious fumes. In the mirror manufacturing process, VOC's come from the paint and solvents used to dilute the paint. These fumes are captured at the sources: the paint coater and the curing oven and routed to an afterburner/incinerator to be treated. The thermal process burns the entire mirror manufacturing VOC's and converts them into harmless carbon dioxide and water.

Liquid/Solid Waste
There are numerous opportunities to recycle and reuse materials used in the mirror manufacturing process. The paint used for the protective backing is applied during a process where it recirculates between the point of application and the paint reservoir, so very little to no paint is wasted. Improvements in packaging design and a reduction in use of consumables have led to less waste of packaging materials. Depending on the type of oven used to cure the mirror-backing paint, heat can be re-circulated, thereby reducing energy costs. Mirrors that are broken or rejected during the manufacturing process can be cut off-line to minimize waste, reducing the volume of material destined to the landfill.