CARDINAL CG

Cardinal Customer Quality Guidelines

1. QUALITY CLASSIFICATIONS

Glass products used for and produced by Cardinal Coated Glass facilities, conform to the following ASTM documented specifications;
ASTM C 1036 (Standard Specification for Flat Glass) Q3/Glazing Select
ASTM C 1048 (Standard Specification for Heat-Treated Flat Glass)
ASTM C 1376 (Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass) Kind CV specification.

2. VISUAL INSPECTION CRITERIA

Defects shall be viewed in transmission using daylight or simulated daylight of no less than 400 lux, utilizing a viewing angle of 90 °. If a light box is used as the light source, the diffusing plate shall be parallel to and at a distance of 5 feet from the window. If you are inspecting overhead windows, the window will be 10 feet from and parallel to the diffusing plate. If defects are visible beyond what is allowable as listed below using the inspection criteria, the glass may be rejected.
Central Viewing Area- The middle 80% of the lite in an oval shape is considered the central area. The central area shall be inspected at a distance of 3 feet from the observer.
Border Area- the border area is comprised of the outer 20 % edge of the lite. The border area shall be inspected at a distance of 10 feet from the observer.

ALLOWABLE DEFECTS

Coating Defect Type	Central Viewing Area – Allowable defect size	Border Viewing Area – Allowable defect size
Pinhole or Debris	1/16" or 1.6 mm (see description 1)	3/32" or 2.4 mm
Coating Scratch	1" or 25 mm max length	3" or 75 mm max length
Coating Rub	Not allowed	Length plus width not to exceed ¾" or 19 mm
Corrosion	Not allowed	Not Allowed

1. **Debris, Dirt, Spots** in central viewing area– must be 1/16" or less. No more than 5 allowed in a 12" area.
2. **Arcing/Crazing**- ≤1/2", on edge only
3. **Seeds, Bubbles, Knots, Stones** –must be 1/16" or less, must be separated by 24".
4. **Chips – Corners:**
   a. **Adhesive Chips**- None allowed
   b. **Shell chip**- No more than ¼" wide by ¼" long and less than ½ the thickness of the glass in depth. No more than one per side.
   c. **Flake chip**- < 1/64", no limit
   d. **Corners** – Flares are allowed within the dimensional tolerance of the unit.
   e. **Corner off** – Up to ¼" if edge surface is smooth. Rough damage is not allowed.
5. **Coating** – Must be uniform on the lite inspected, when viewed in transmission using the inspection criteria previously stated above.
6. **Dimension**- +/- 1/16" on all annealed cut size products and +/- 1/16" on all stock & tempered glass.

7. **Bow**- 1/32" per foot + 1/32" for all tempered products.
8. **Glass Thickness**- per ASTM

DEFECT DEFINITIONS

1) **Bow/Warp:** a deviation in the flatness of the glass, typically defined by Holding, Shedding, S Warp or Kink.
2) **Chips:**
   i. **Adhesive Chip-** a small piece of glass adhered to the surface- typical to tempered glass
   ii. **Flake Chips:** shallow chips at the edge of the glass, much like a shell chip but smaller.
   iii. **Shell Chip:** a smooth, shell like chip at the edge of the glass
3) **Coating Debris:** irregular areas of missing coating creating voids in the surface
4) **Arcing/Crazing:** a random conglomeration of fine lines or micro cracks in the coating, may be similar in appearance to a lightning bolt.
5) **Corrosion:** degradation of the coated surface, may appear as spots with irregular edges
6) **Dimension:** the specifications for the size variation allowed on a piece of glass
7) **Glass thickness:** the upper and lower specifications for glass thickness
8) **Interleaving Material:** material used to protect glass from damage during handling, packing, and transportation.
9) **Logo:** A permanent mark required on all tempered glass to identify the producing plant and verify process certification.
10) **Scratch:** A marring of either surface of the glass, may be linear or otherwise
11) **Seed, Stones, Bubbles, Knots:** an inclusion within the body of the glass that results in a point defect that may include distortion.

SHELF LIFE OF LoE COATINGS

Per Cardinal Technical Services Bulletin # CG-05-05/08, Cardinal Non Temperable LoE coatings carry a 6 month shelf life from the date of receipt from the manufacture and Temperable LoE coatings carry a 3 month shelf life. Post tempered monolithic LoE products must be built into an insulating glass unit within 48 hours.

All products must be kept in a clean, dry warehouse and be kept free of all forms of moisture, whether from localized water sources, or condensed moisture on the surface, as well as the edges of the glass.

Deterioration of the coating will, in most cases, be moisture migrating from the surface of the coating through the silver layer(s) causing a "spot". The "spot" will, in most cases, be circular in shape and may have a silver appearance.

Coating deterioration is not necessarily a "shelf life" issue, but may be a storage issue. Moisture or other airborne volatiles (evaporative solvents) that are allowed to come into contact with the coated surface while the glass is being stored may contaminate and permeate the surface of the coating. The result may be coating deterioration in the form of corrosion. See STORAGE OF CARDINAL LOE GLASSES for recommended storage procedures.

CARDINAL CG

STORAGE OF CARDINAL LoE COATED GLASSES

Per Cardinal Technical Services Bulletin # CG-05-05/08, Standard LoE coated glass in stock sheets or on steel racks in cut sizes can be stored safely for a period of up to 6 months in a dry, clean warehouse storage area at room temperature. Temperable LoE coated glass can be safely stored for 3 months. The storage area should be away from sources of high humidity; washing equipment, bay doors, truck exhausts acids or other chemicals or processes that may expose the product to possible contaminants. Storage areas should not have large changes in temperature and humidity but maintain constant environmental conditions that are controlled if at all possible. Adequate air movement and ventilation is required to maintain the durability of the coating. It is highly recommended that fans be pointed at open racks or packs of the Temperable version of LoE products at all times.

If a portion of the glass in stock sheets or boxed cut sizes is used, the remaining glass lites should be tightly packed and resealed/taped closed with desiccant inside the packaging to protect the LoE coating from possible deterioration. We recommend the original plastic be neatly opened by cutting across the bottom and up both sides, creating a flap that can be taped down to close between uses, insuring that desiccant is maintained inside the package. We recommend that slow moving glass and cut sizes be fabricated as soon as possible to reduce any possibility of uncontrolled environmental conditions that could affect the coating. Rotation of stock is critical to insure shelf life compliance. Cardinal can only guarantee product for the 3 and 6 month shelf life listed above. **Case tags should remain with the glass at all times and are required to report a problem or claim**.

HANDLING:

LoE glass should be handled at the edges or from the bottom with clean soft gloves, and all processing of these coated glasses should be with the coated surface away from conveyor rollers or cutting table surfaces. The coated surface should always be up on the cutting table. In processing coated glass after cutting, if harp type carts are used, a procedure should be established whereby the glass is leaned toward the non-coated surface during insertion and removal from the cart. This prevents scraping damage of the harps against the coated surface. The harp materials should be soft so as not to damage the coating and should be inspected frequently and replaced as necessary. A frequent wiping down with isopropyl alcohol is also recommended to remove dust and dirt. It is possible that the coating could be damaged by contact with acids associated with perspiration, saliva, fingerprints, oils, etc. The following are some of the current glove types used at Cardinal Coated Glass Facilities:

1. Atlas Blue Majic glove (Latex coated cotton) – used to handle clear raw glass.
2. Latex disposable glove – 1st of 3 gloves used to handle coated glass.
3. Econo Men's 2pc Jumbo (Cotton glove) – 3rd of 3 gloves used to handle coated glass (Coated glass handled by edges but glove has limited contact with coating and prevents abrasion/scratches).

Cardinal Glove Supplier Information:

Contact the supplying CG Plant Salesman or Quality Department for assistance with glove approval or selection.

Coated Glass Cutting information:

Cardinal recommends that LoE products be cut using an evaporating or water soluble cutting fluid. It is further recommended that once cut, fabrication takes place within 24 hours. Cutting fluids that have been successfully tested and are compatible with LoE coated glass products are;

Part # ACE 5503/D, Evaporating Cutting Oil

Part # 62356 Magnudraw Vanishing Oil

Perfect Score vanishing fluid

Cool Cut Cutting Oil

Identification of LoE surfaces

Ways to identify the LoE surface are as follows;

- Shipping labels may indicate coating direction.
- The use of an Ohmmeter or continuity tester. This will indicate conductivity on the coated surface when the probes are pressed onto the coated surface. These units are available at most electrical or hardware stores.

WASHING AND DRYING RECOMMENDATIONS FOR LoE COATED PRODUCTS

Experience has shown the IG line washer to be one of the most critical areas to monitor for the successful processing of LoE products.
The following recommendations are made to reduce the opportunity for problems while LoE coated products are mechanically washed and dried. LoE coated glass must be washed with the coating side up (away from rollers). The glass should not be permitted to stop in the washer or have a dwell time under the brushes or air knives as coating scratches and or abrasion to the coating may occur. A mild washing detergent or cleaner and a water temperature of **120°F** maximum should be used.
See below for a list of recommended detergents:

Basic H Organic Cleaner and Surfactant **Sommaca LoE Soap**

Wash water should be neutral as possible (PH of 7 +/- .5), a PH of 7 is considered neutral. Above 7 is alkaline and below 7 is acidic, the amount above or below 7 determines how alkaline/acidic the water is. Acid from interleaving materials on the companion clear glass lite may cause the water to become acidic. Lucor interleaving used on most uncoated glass contains Adipic or Boric acid and Lucite (acrylic beads). This may cause corrosion of the LoE coating if proper washer maintenance is not performed. Cardinal's LoE coated glasses use only Lucite (non acidic) as the interleaving material.

The following are recommendations for mechanical washer systems maintenance. Refer to your manufactures' recommendations for additional support.

It is highly recommended that wash water be filtered/treated (DI – deionized, DM – demineralized, RO – reverse osmosis) or a system other than basic tap water is utilized. A routine scheduled maintenance program is essential to provide the best possible glass cleanliness, and insure that potential problems are resolved before production time and value added processes are utilized for the fabrication of coated products into insulated units.

Prewash – Filters on detergent solution (Neutral PH) and high-pressure water lines must be changed when necessary. Filter replacement should be determined due to supplier recommendations for pressure differentials of filter sumps, productions throughput and visual inspections, or as dictated by production and maintenance experience. Inspection and necessary cleaning of blocked or corroded nozzles is

required and visual system inspections will usually determine a scheduled maintenance timeframe. Holding tanks should be drained and rinsed every 24 hours. Water source should be filtered and some type of purification system used (treated/RO/DI/DM).

Main Wash System – Filters should be changed as necessary based on supplier recommendations, production experience and/or any internal washer maintenance programs (Highly recommended). Draining and recharging of washer tanks is recommended as for the Prewash systems, however this will not prevent accumulation of any scale or sediment on tank surfaces. Tank scrubbing or steam cleaning on a routine scheduled basis is necessary to remove these types of deposits. Wash and rinse brushes must be checked and adjusted as necessary to insure proper glass surface contact. Worn brushes should be replaced, and brush sections should be steam cleaned on a routine scheduled basis. Final rinse water should be either DI/DM treated water to insure that mineral deposits are not present prior to the air knife section. Adequate rinse water flow is critical so that brushes and air knifes are not abrading the coating due to "running dry". Air knife filters and lines are extremely critical as this is the final step before most fabrication processes occur. Air knife flow, filter maintenance, and adjustments must be checked periodically to insure proper drying of the glass surface. All water should be visibly removed prior to IG fabrication and the glass should be viewed with sufficient lighting to insure that any blow-off or streaking is not visually evident. Improper alignment or dirty airflow will result in possible blow-off patterns causing a defective product that may not be identified until value-added fabrication processes have occurred.

Recommended maintenance schedule review:

- ✓ Drain and refill tanks at least once every 24 hours
- ✓ Visual Inspection of filters and washing systems at least once every 24 hours or more (Scheduled routine maintenance checks). Replace as necessary.
- ✓ Visual inspection of air knives for proper flow and adjustment at least once every 24 hours. Steam clean, change filters, and adjust as necessary.
- ✓ Weekly detailed inspection of washer systems to include steam cleaning of washer brushes and tanks. Clean rolls if necessary.
- ✓ If any problems occur that may be related to the washer systems, an unscheduled check of washer systems may be necessary to identify any correct the situation.
- ✓ Run washer systems 1 to 2 hours after maintenance to flush and filter any loosened sediment or deposits.
- ✓ Washer brushes known to work well with coated glasses are:
  Dupont nylon .010" bristle diameter, close wound high-density bristles.

  One supplier of these types of brushes is:

  Billco MFG Co. (724) 452-7390

IG UNIT FABRICATION

It is the responsibility of Cardinals customers to determine the compatibility of primary and secondary sealants, desiccants, gasses, muntin bars or other materials used in the fabrication of IG units with coated glass.

Organic materials driven off by some sealant systems, muntin bars, and other components can condense on the LoE coated glasses and produce an optical fogging effect and/or damage to the coating. This fogging effect may not be seen on glass, but a visual obstruction could be produced and/or coating degradation could occur. It is recommended that sealant materials, cleaners, muntin bars or spacers that outgas organic materials not be used in the IG unit fabrication.

Cardinal recommends IG manufacturers to pass either:

1. IGCC Certification requirements of Class CBA
2. ASTM Specification E773-88, Seal Durability of Sealed Insulating Glass Units, and ASTM E774-88 Specification For sealed Insulating Glass Units (Class CBA) Canadian National Standard CAN 2-12.8-M76

Cardinal believes the best unit construction with LoE coatings is a dual seal unit with a continuous, uniform, non-interrupted polyisobutylene primary sealant with bent spacer corners or the blocking of all open corners and butt-splices, used in conjunction with compatible secondary sealants. Other dual seal and single seal insulating glass constructions have been successfully used with LoE coated glasses. It is recommended that the IG sealant manufacturer(s) be contacted to assure that the sealant systems used are tested and compatible with the LoE coated glasses.

IG units should be manufactured with the coating on the number two or three glass surface of a dual pane unit (Surface #2 and/or #5 for a triple pane unit). Performance information when LoE coatings are used on the number two or number three surfaces is detailed in Cardinal's literature.

EDGE DELETION

Edge deletion tolerances differ from Cardinal facilities based on target width desired. The maximum upper spec limit provided is 7/16" and the smallest lower spec limit provided is ¼". This range of deletion provides enough coating removal to ensure a sound mechanical seal per Cardinal Technical Services Bulletin # CG-01-05/08.

Per Cardinal Technical Services Bulletin # CG-01-05/08 LoE coatings are similar to mirrors in that they both use silver, experience with the weatherability of mirrors can be used to determine the failure mechanism and weatherability of LoE coatings. A failure of mirrors normally occurs from the edge, caused by corrosion of the silver. Within the industry, this is termed the "black edge effect". When mirrors are exposed to relative high humidity levels or are exposed to common cleaning solutions containing acids (even though diluted), the mirror can have silver corrosion. It is important to note that the silver degradation occurs from the edge and propagates from this point.

Test conducted on non-edge deleted and edge deleted LoE insulating glass units indicate the silver corrosion that occurs on the non-edge deleted LoE coatings could be affected by moisture, diluted acidic acids, such as acid rain or cleaning solutions. All glazing systems permit, to varying degrees, the edge seal of an insulating glass unit to be exposed to moisture, cleaning solutions, and possibly acid rain, depending on the climate conditions. Cardinal LoE coatings should only be used in glazing systems with properly designed and functioning weep systems. Moisture, cleaning solutions and acid rain could cause the LoE coating to corrode in the sealant area around the periphery similar to the "black edge effect" on mirrors. The length of time to cause this corrosion will vary with the amount of exposure. To reduce the possibility of corrosion taking place it is highly recommended that edge deletion take place. It is recommended that deletion take place using an edge grinding technique that removes the silver layer of LoE coatings.

Advantages of edge deletion are as follows:

- Bonding of sealants to glass, not to a coating
- Reduction of the potential for coating corrosion caused by moisture, cleaning solutions, acid rain, etc.
- Reduction of the potential for delamination of the LoE coating
- Reduction in the potential for seal integrity compromise

CARDINAL CG

CREDIT POLICY FOR DAMAGED OR DEFECTIVE GLASS

1. All glass products provided by Cardinal are shipped with multiple crate tags that include information as to glass size, coating type, thickness, quantity, production date, specific serial number, etc. Any credit request must have the case tag information available so Cardinal may research and initiate any necessary corrective actions. If the Customer utilizes their own inventory system, information must be available that correlates the Cardinal crate tag information with the Customer's inventory system. **Credit may be denied if Cardinal case tag information is not available.**
2. Credit requests must be communicated, at a minimum, on a monthly basis. Credit requests for a full month need to be received by the 10th day of the following month. If credit requests are held for periods of more than one month, credit may be issued over a period equal to that of the credit accumulation.
3. Cardinal reserves the right to inspect any damaged glass or glass products that are considered to be defective.
4. Rejects of a routine nature should be held for inspection by a Cardinal CG representative.
5. Any major (or considered major) problems with damaged glass or quality problems should be reported immediately to Cardinal. Photos, samples or the entire product in question must be saved for Cardinal inspection.
6. Any questionable defective glass should be inspected using the following ASTM Specifications; 1036 Flat Glass-Q3/Glazing Select, 1048 Heat Treated Flat Glass and 1376 Pyrolytic and Vacuum Deposition Coatings on Flat Glass. Glass with unacceptable defects per the ASTM should be held for review by a Cardinal Representative.
7. Cardinal will be liable for transportation damage on goods shipped FOB customer destination provided the Bill of Lading is noted for such damage. Approved notation will include the driver and receiver's signatures agreeing the damage is present. A copy of the BOL must be forwarded to Cardinal. Failure to indicate damage on the BOL may result in denial of claim. Shipments via contract haulers or customer will-call should be inspected at pick up. Signature indicates the shipment is in good condition when leaving the Cardinal dock. Signature on a Bill of Lading indicates an inspection upon receipt, and releases the carrier of any liability for transportation damage. Cardinal cannot be held liable for concealed damage. We will not accept any liability for damaged glass when transported on an unauthorized truck line, and any claim issues for glass transported in this manner must be initiated by the Customer.
8. Mark and Pack Rule: Stock glass may be marked (75% of the marked lite must be usable) for up to 10% of the quantity per container unless otherwise agreed to in writing by Cardinal and the Customer. Credit will be issued for the unusable square footage when documentation is provided that references the Cardinal case tag information.
9. Refer to Cardinal Glass Industries Technical Services Bulletin #CG05-5/08 for information regarding the shelf life of coated products.

It is our intent to assist our customer as diligently as possible when they have a problem. By following the above guidelines and recommendations, misunderstandings and problems can be addressed and corrected as soon as possible.