SECTION 2.1— SPECIFICATION NO. 89-1-69 REV. #2

Specification for Environmental Durability of Heat-Treated Spandrel Glass with Applied Opacifiers

A. Scope

This specification shall cover opacifiers such as applied films, organic coatings and adhesive laminates, which are applied to the interior (non-weathered) surface of heat-treated glass. Refer to ASTM C1048 for heat-treated glass standard.

Spandrels with ceramic enamel are not addressed by this specification.

Refer to Engineering Standards Manual Specification No. 66-9-20 (Section 2).

Laminated glass is not addressed by this specification. Refer to ANSI Z97.1.

B. Applicable Specifications

Other specifications which may be referenced within this specification, either in whole or in part, are as follows:

ASTM C1036	Standard Specification for Flat Glass
ASTM C1048	Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
ASTM G153	Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
ASTM G154	Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Non-Metallic Materials
ASTM G155	Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials
CAN/CGSB-12.9	Spandrel Glass
CAN/CGSB-12.20	Structural Design of Glass for Buildings
ANSI Z97.1	American National Standards for Safety Glazing Materials Used in Building – Safety Performance Specifications Method of Test
CPSC 16 CFR 1201	Safety Standard for Architectural Glazing Materials

GANA Glazing Manual, 50th Anniversary Edition
Engineering Standards Manual Appendix 6

C. Objective

For certain applications, heat-treated glass with an applied opacifier on the interior surface may be the preferred choice for use in building facades. The objective of this specification is to ensure the durability of heat-treated glass

spandrels with an opacifier. A test method to validate fallout resistance has been included for those projects that have this requirement based upon applicable codes or project specifications.

D. General Requirements

For best assurance that products covered by this specification are properly fabricated, certain tests are prescribed. Further, glass spandrels with an applied opacifier can require special consideration and/or handling in their application and installation. For these reasons, the following considerations are recommended:

Glazing practices for glass spandrels with an applied opacifier can significantly affect the durability of the glazed panel. It is essential that no glass-to-metal contact, improper glazing methods or inadvertent contact occur which will impart damages to the glass edges and surfaces or to the opacifier. Precaution should be taken to protect glass spandrel surfaces against welding spatter, surface and/or edge handling damage, and any other conditions which may adversely affect the strength of the glass. Chemical compatibility of the opacifier with other materials used in the spandrel cavity is critical. A chemical instability may result from aggressive adhesives applied to the opacifier, the use of insulation with unstable resins or binders, overspray of fire-safing with high amounts of petroleum distillates, adhesives or paints which outgas, household detergents used as lubricants, solvents used in cleaning, primers used in structural glazing or low-grade glazing gaskets. These chemicals, in combination with other factors such as moisture, heat and/or ultraviolet exposure, may aggressively attack the opacifier, certain glass coatings, and the glass itself. Consultation with the component supplier regarding chemical compatibility and project specific testing is essential.

The compatibility of materials is essential to the long-term performance of any glazing installation. Chemical reaction from physical contact or close proximity exposure to incompatible materials can occur. Compatibility should always be a concern and should never be assumed.

Good starting points for guidance include: ASTM C510 *Standard Test Method for Staining and Color Change of Single or Multicomponent Joint Sealants*, C 794 *Standard Test Method for Adhesion-Peel of Elastomeric Joint Sealants*, C864 *Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers*, and C1087 *Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems*.

All heat-treated glass with an applied opacifier shall be glazed in accordance with the GANA Glazing Manual, 50th Anniversary Edition or as recommended by the spandrel manufacturer.

Insulation must be applied strictly in accordance with the spandrel glass manufacturer's specifications. Some manufacturers do not recommend the application of insulation directly in contact with their opacified glass spandrel products.

Some manufacturers of spandrel glass products can furnish panels with an applied opacifier which is intended to retain glass in place should breakage occur. Broken panels should be removed as soon as possible. For spandrel applications requiring glass fallout protection to meet applicable codes or project specifications, spandrel panels with an applied opacifier are recommended.

D.1 Environmental Durability Testing of Opacifier Bond

D.1.1 Specimens to be Tested
Fifteen (various sizes – check test labs) specimens, each affixed with an opacifier and representative of the end product, shall be prepared for the four tests indicated: high temperature – low humidity, high temperature – high humidity, cyclical temperature and humidity, and ultraviolet radiation. Three samples shall be retained as control specimens. For test purposes only, because of heat-treating equipment limitations on small sizes and because of lab apparatus limitations on large sizes, annealed glass may be used.

D.1.2 Test Aparatus
A humidity chamber shall be capable of providing and controlling temperatures -28.9°C to 93.3°C ± 2.8°C (-20°F to 200°F ± 5°F) and humidity (up to 95 percent) for the cyclical periods as required in D.1.3.3.

D.1.3 Test Procedure

D.1.3.1 High Temperature – Low Humidity Test
Place three specimens positioned vertically and separated by at least 25 mm. (1 in.) air space in a humidity chamber for 3 days (72 continuous hours) at 93.3°C (200°F) and ambient humidity. Interpretation of results is expressed in paragraph D.1.4.

D.1.3.2 High Temperature – High Humidity Test
Place three specimens positioned vertically and separated by at least 25 mm. (1 in.) air space in a humidity chamber for 7 days (168 continuous hours) at 93.3°C (200 °F) and 95 percent relative humidity. Interpretation of results is expressed in paragraph D.1.4.

D.1.3.3 Cyclical Temperature and Humidity Test
Three specimens are placed vertically in a humidity chamber and subjected to 100 cycles, each cycle to proceed in sequence, a, b, c and d as follows and repeat with no time delay between cycles:

a. 1 hour at -28.9°C (-20°F) at ambient humidity.

b. During the next 3 hours, elevate temperature from -28.9°C (-20°F) to 93.3°C (200°F) with relative humidity at 95 percent beginning above the 4.4°C (40°F) temperature level.

c. Hold for 1 hour at 93.3°C (200°F) at 95 percent relative humidity.

d. During the next 3 hours, decrease the temperature from 93.3°C (200°F) to -28.9°C (-20°F) at ambient humidity. Interpretation of results is expressed in paragraph D.1.4.

D.1.3.4 Ultraviolet Radiation Test

D.1.3.4.1 Specimens to be Tested
Three specimens, each affixed with an opacifier and representative of the end product, shall be prepared for the test indicated.

D.1.3.4.2 Test Apparatus
An accelerated weathering apparatus will be provided, such as:

Carbon arc lamp – as referenced in ASTM G153

QUV chamber – as referenced in ASTM G154

Xenon lamp – as referenced in ASTM G155

D.1.3.4.3 Test Procedure
Three specimens with the opacified surface facing away from either radiation source shall be exposed for 1,000 hours in the manner described in ASTM D1499. Radiation striking the specimens should be the same intensity as solar radiation of 1400 W/M2 for the 1,000 hours. The temperature of the specimens shall be maintained within 37.8°C to 48.9°C (100°F to 120°F) throughout the test. The three remaining specimens shall be maintained as controls.

D.1.4 Interpretation of Results
The exposed samples when compared to the control specimens shall not exhibit any bubbles, peeling, crazing, cracking, tunneling, shrinkage, staining, discoloration or delamination of the opacifier, in tests D.1.3.1, D.1.3.2, D.1.3.3 and D.1.3.4. Staining of the glass is permitted for test purposes only.

D.2 Compatibility of Components in the Spandrel Cavity
The compatibility of the opacifier material with sealants, gaskets, thin film coatings or other materials with which it may come into contact needs to be evaluated.

D.2.1 Test Procedure
The testing method must be representative of the conditions found in the installed application. Certain existing methods, such as ASTM C1087, although not specifically designed to assess opacifier compatibility, may provide some guidance as to sample preparation and testing conditions. The manufacturers of sealants, gaskets, coatings on glass and opacifying materials should be consulted on other potential testing methods or assessment techniques.

D.2.2 Interpretation of Results
Incompatibility may be indicated by the occurrence of bubbles, peeling, crazing, cracking, tunneling, shrinkage, staining, discoloration or loss of adhesion. These occurrences may be seen in the opacifier or other components of the system (i.e. sealant, glass surface, setting block, gasket, etc.).

D.3 Fallout Resistance Test
When specified, spandrel glass with an opacifier shall meet the fallout resistance requirements when tested in accordance with D.3.3.

D.3.1 Specimen to be Tested
The size of the four heat-treated opacified specimens shall be 86.40 cm (34 in.) x 1.93 cm (76 in.) with a tolerance of ± 0.32 cm (0.125 in.) on each dimension.

D.3.2 Test Apparatus
Each opacified specimen shall be mounted for testing in a test frame as specified in ANSI Standard Z97.1 as modified to conduct pressure test of D.3.3.3.

D.3.3 Test Procedure

D.3.3.1 Test for 100 cycles, each cycle to proceed in sequence a, b, c and d as follows, and repeat with no time delay between cycles:

a. One hour at -18°C (0°F) at ambient humidity.

b. During the next 3 hours increase temperature from -18°C (0°F) to 82.2°C (180°F), with relative humidity at 95 to 100 percent above 4.4°C (40°F).

c. Hold for 1 hour at 82.2°C (180°F) at 95 to 100 percent relative humidity.

d. During the next 3 hours, decrease temperature from 82.2°C (180°F) to -18°C (0°F) at ambient humidity.

D.3.3.2 Fracturing Glass
While the specimen is in the test frame, break specimen using a spring-loaded prick punch at the midpoint of either vertical edge and 25 mm (1 in.) inboard of the edge. Cracks and fissures of the opacifier which may develop are permissible, providing they conform to the requirements of D.3.4.

D.3.3.3 Static Pressure
Subject each specimen after breakage to 10 cycles of positive and negative pressure at 4 pounds per square foot (psf) for 5 minutes to simulate the action of wind load against a building.

D.3.4 Interpretation of Tests
Although cracks and fissures are permissible, no opening shall occur through which a 7.62 cm (3 in.) sphere may be freely passed, nor shall there be areas in which the opacifier is detached from the glass more than 58.1 sq. cm (9 sq. in.).

D.4 Viewing and Inspection of Surface Quality in Opacified Spandrels
Spandrel glass is designed to be viewed from the exterior against an unlit, uniform background. The glass with the applied opacifier, when placed in a vertical position and viewed at a distance of three meters through the glass (glass surface facing observer) in daylight, shall have a uniform appearance; free from blisters, bubbles, cracks, folds, uneven butt joints or tears.