American National Standard

Repair of Laminated Automotive Glass Standard (ROLAGS™)

ROLAGS™
Repair of Laminated Automotive Glass Standard

ANSI/AGSC/NWRD/ROLAGS 002-2022

ANSI/AGSC/NWRD/ROLAGS
002-2022
(revision and redesignation of
ANSI/NWRA/ROLAGS 001-2014)

American National Standard

Repair of Laminated Automotive Glass Standard (ROLAGS™)

Secretariat

Auto Glass Safety Council

Approved December 8, 2022

American National Standards Institute, Inc.

American National Standard

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Published by

Auto Glass Safety Council (AGSC)
National Windshield Repair Division (NWRD)
PO Box 569, Garrisonville, VA 22463

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Printed in the United States of America

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Foreword (This foreword is not part of American National Standard ANSI/AGSC/NWRD/ROLAGS 002-2022.)

The Repair of Laminated Automotive Glass Standard (ROLAGS™) was created by the Auto Glass Safety Council's National Windshield Repair Division working under the auspices of the American National Standards Institute (ANSI). AGSC/NWRD also serves as secretariat for the standard.

ROLAGS represents the windshield repair industry's best practices as complied under ANSI guidelines by a balanced committee of windshield repair and replacement practitioners, suppliers and other interested parties.

ROLAGS contains an industry consensus of recommended terminology, definitions, process, and procedures. These recommendations reflect the expertise of the AGSC NWRD ROLAGS 2 Standards Committee members who hold a combined experience of hundreds of years and many thousands of actual windshield repairs.

This standard contains five annexes. Annexes A, C, and D are normative and are considered part of this standard. Annexes B and E are informative and are not considered part of this standard.

Suggestions for improvements of this standard will be welcome. They should be sent to the Auto Glass Safety Council/National Windshield Repair Division, PO Box, Garrisonville, VA 22463.

This standard was processed and approved for submittal to ANSI by the ROLAGS 2 Standards Committee of the Auto Glass Safety Council's National Windshield Repair Division. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this edition of the standard, the ROLAGS 2 Standards Committee had the following members:

Linda Rollinson, Chair, AGSC NWRD ROLAGS 2 Standards Committee
(Superior Auto Glass of Tampa Bay, LLC – New Port Richey, FL)

Company Represented	*Name of Representative*
Auto Glass Inspections Services	Lenny Hennessy
Auto Glass Repair & Replacement Magazine	Debra Levy
Beveridge & Associates	Keith Beveridge
City Auto Glass	Mike Schenian
Delta Kits (Eugene, OR)	Korey Gobin
Don's Mobile Glass	Jacques Navant
Equalizer Industries, Inc.	Gilbert Gutierrez
Fremont Auto Glass	John Payne
GEICO Insurance	Brad Conley
Glass Mechanix Solutions	Aric Haarala
Glass Technology Inc. (Durango, CO)	Rory Most
GlasWeld Systems	Shiloh Spoo
Novus 2, LLC	Jay Bickford
Orion Registrar, Inc.	Penny Ouellette
Pitstop Autoglass/Windshield Repair Service Center	Gil Rucker
Superior Auto Glass of Tampa Bay, Inc.	Linda Rollinson
Ultra Bond (Grand Junction, CO)	Richard Campfield
Wise Cracks	Mark Van Antwerp
Wyndshyld Auto Glass	Glenn Fell

Introduction

NOTES:

1) The conversion "One inch equals 25 mm" is used throughout this standard.

2) *Windshield Repair* and *Repair of Laminated Auto Glass* are used interchangeably throughout this standard.

Windshield Repair is a permanent process that can be used to repair a laminated windshield that has been damaged.

There are two basic causes for damaged laminated auto glass.

Impact: This is the most common and occurs when an object strikes the glass;

Stress or Twist: A crack occurs when a windshield is twisted, either by flexing within the vehicle frame or because of improper mounting.

The concept of repairing laminated windshields first appeared in 1968. The subsequent development of chemicals and tools, specifically designed for repair of laminated auto glass, has enabled windshield repair, if performed by a trained professional, to usually achieve the following on a finite area of the exterior surface:

- Improve the optical clarity of the damaged area

- Restore a smooth surface to prevent interference with the wipers

- Stop the damage from spreading by adding strength to the damaged area

- Retain the original bond, if applicable, by eliminating the need to replace the windshield

American National Standard

Repair of Laminated Automotive Glass Standard (ROLAGS™)

1. Scope

The Scope of this standard shall be to define:

- Repairable damages;
- The process of windshield repair;
- The performance criteria for repaired laminated glass.

This standard shall also provide best practices for the training of a repair technician.

2. Purpose

It is the intention of the Repair of Laminated Automotive Glass Standards Committee (ROLAGS™) that this document:

- Be used to consistently evaluate damages on laminated auto glass in order to aid in the decision to repair or replace the glass;
- Assist the public in understanding what is achieved through windshield repair (repair of laminated auto glass);
- Encourage technicians to strive for the highest quality repair;
- Codify the current best practices of laminated auto glass repair.

3. Normative References

See annex A.

4. Glossary of Repair Terminology

4.1 Bullseye: Damage that is marked by a separated cone in the outer layer of glass that results in a dark circle with an impact point.

Figure 1 – Bullseye

4.2 Chip: Non-technical term, commonly used by the public, for damage on a windshield.

4.3 Combination Break: Damage with multiple characteristics, i.e., star within a bullseye, short or long crack(s) emanating from the damage.

Figure 2 – Combination Break

4.4 Crack: Single line of separation that may emanate from an impact point.

4.4.1 Short Crack: A crack of 6 inches (150 mm) or less.

4.4.2 Long Crack: A crack of more than 6 inches (150 mm).

4.4.3 Edge Crack: Any crack that extends to an edge.

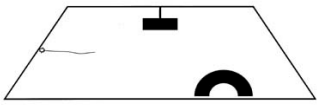

Figure 3 – Edge Crack

4.4.4 Floater Crack: Any crack that does not extend to an edge.

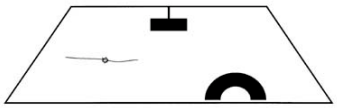

Figure 4 – Floater Crack

4.4.5 Stress Crack: Any crack that extends from an edge and lacks an impact point.

4.5 Damage: A break in laminated glass.

4.6 Ding: Non-technical term, commonly used by the public, for damage on a windshield.

4.7 Half Moon: Partial bullseye.

4.8 Impact Point: Location on the glass that was struck by an object and results in damage.

4.9 Laminated glass: Two or more layers of glass with a non-glass inner layer(s).

4.10 Legs: Subsurface cracks that emanate from the break.

4.11 Lite: A single layer of glass.

4.12 Pit: Impact point from which a small piece of glass is missing.

4.13 Repair: A process that removes air from the break either by vacuum or displacement and fills the break with resin.

4.14 Star Break: Damage that exhibits a series of legs that emanate from the break.

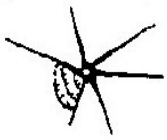

Figure 5 – Star Break

4.15 Stone Break: Non-technical term, commonly used by the public, for damage on a windshield.

4.16 Surface Pit: A nick in the glass associated with normal wear and tear that does not penetrate to the plastic interlayer.

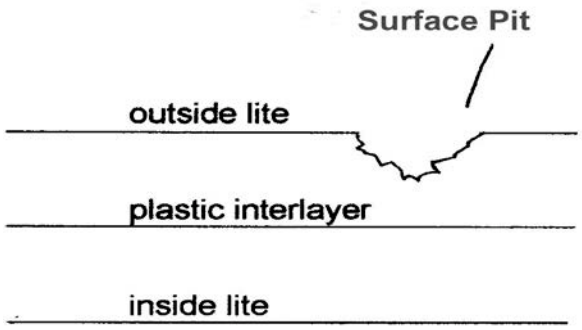

Figure 6 – Surface Pit

4.17 Typical Portrayal of Windshield Damage, Adequate and Inadequate Repairs: See annex E.

5. Other Related Terminology

5.1 Binocular Vision: Vision in which both eyes are used together. Human vision compensates for an obstruction to the vision of one eye with the unimpeded vision of the other eye. If both eyes are obstructed, no compensation is possible and a blind spot occurs. Thus, two windshield repairs, in the same proximity may cause the aforementioned phenomenon. This restriction is limited to the Driver's Primary Viewing Area.

5.2 Cosmetic Blemish: A remnant of damage that is still visible after the repair is completed.

5.3 Distributor: Any firm that purchases, for resale, complete repair kits or parts of kits from manufacturers.

5.4 Driver's Primary Viewing Area (DPVA): An area on the exterior of the windshield:

- 12 inches wide (300 mm wide);
- Centered on the driver's position;
- Extending from the top to the bottom of the wiper sweep.

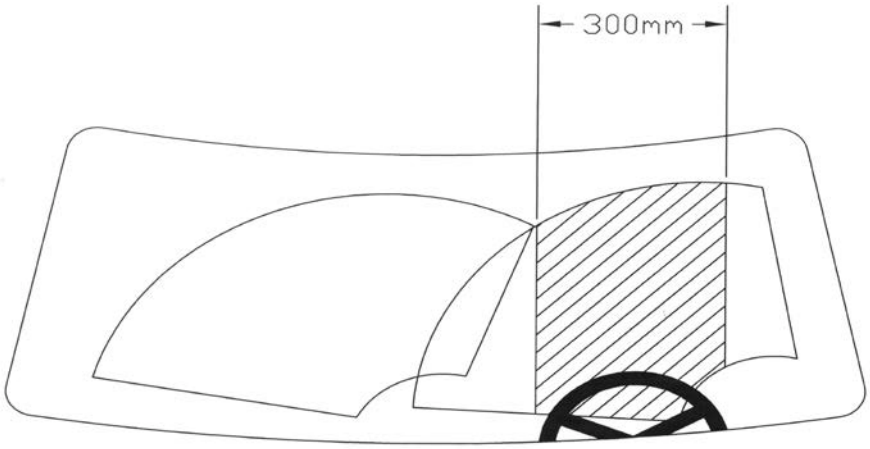

Figure 7 – Driver's Primary Viewing Area (DPVA)

5.5 Manufacturer: Any firm that produces equipment, resins, or other materials used in the repair of laminated auto glass.

5.6 Plastic Interlayer: Layer of plastic that bonds two pieces of glass that may also be referred to as the laminate or PVB (polyvinyl butyral).

5.7 Refraction: The bending of light rays while passing from one medium to another.

5.8 Resin: An organic material that approximates the refractive index of the laminated glass and, when cured, will seal the break or crack.

5.9 Wiper Sweep: An area on the windshield cleaned by a motorized arm with a flexible blade attached.

5.10 Value-Added Features: Items added to the windshield, by the manufacturer, such as certain coatings, rain sensors, heads-up displays (HUD), Night Vision, Global Positioning Systems (GPS) antennas, etc.

6. Damage Types and Repairable Dimensions

6.1 Bullseye: With a diameter no larger than one inch (25 mm).

6.2 Combination Break: Diameter of body (excluding legs) not to exceed 2 inches (50 mm).

6.3 Crack: No longer than 14 inches (350 mm).

6.4 Half Moon (Partial Bullseye): With a diameter no larger than one inch (25 mm).

6.5 Star Break: Diameter of the break not to exceed 3 inches (75 mm).

6.6 Surface Pit: Damage with a diameter of not less than 1/8 inch (3 mm).

7. Repair Limitations

Both the location and the condition of the damage are important considerations in the decision to repair. Replacement is recommended under any of the following circumstances, i.e., do not repair:

- Damage that penetrates both the inside and outside layer of a laminated glass;
- Damage with three or more long cracks emanating from a single impact point;
- Damage on the inside lite (layer) of laminated glass;
- Damage contaminated with visible impurities that cannot be removed through cleaning;
- Damage or discoloration to the plastic interlayer;
- Damage in an area of the windshield where value-added features may be negatively affected by the damage and/or the repair process;
    - Repair technicians should consult and follow any vehicle manufacturer's recommendations before performing a repair on any value-added feature (see 5.10);
- Damage with a pit size greater than 3/8 inch (9 mm);
- Edge crack(s) that intersect more than one edge;
- Stress cracks;
- In the Driver's Primary Viewing Area (DPVA) if:
    - Diameter of damage is larger than one inch (25 mm);
    - The finished pit will be greater than 3/16 inch (5 mm);
    - The repair will be within 4 inches (100 mm) of another repair (see 5.1);
- If, in the technician's judgment, the repair will affect the proper operation of the vehicle.

8. Process to be Followed by the Repair Technician

NOTE: All steps given in this clause are to be carried out in accordance with the manufacturer's suggested instructions unless the instructions are in conflict with this standard.

8.1 In order to ensure the best possible repair, the technician shall do the following:

(1) Inspect the damage from both inside and outside the glass to determine if the damage is repairable (see clauses 6 and 7);
(2) Remove moisture, dirt, foreign matter, loose glass, and contamination from the damaged area;
(3) If the temperature of the glass is outside the recommended range, cool or warm the glass accordingly;
(4) Access the damage through probing or drilling;
(5) Protect the resin from premature curing;
(6) Remove the air from the break, either by vacuum or displacement, and fill the void with resin;
(7) Properly perform pit filling and resin curing;
(8) Finish the repair to be flush with the glass;
(9) Inspect the finished repair (see clause 9).

8.2 Crack Repair

(1) Completely fill the crack with the appropriate resin(s);
(2) Place a bead of resin on top the crack;
(3) Properly cure the resin;
(4) Finish the crack repair to be flush with the glass;
(5) Inspect the finished crack repair.

9. Inspection of the Repair Quality by the Technician

- The repair shall be inspected visually from the driver's position within the vehicle.
- The repair should be free of significant light scatter, dirt, road contaminants, air pockets, and other optical defects that may affect the proper operation of the vehicle.
- The finished pit should not be larger than 3/8 inch (9 mm) and is limited to 3/16 inch (5 mm) in the Driver's Primary Viewing Area (DPVA) (see 5.4).
- The repair should not interfere with the normal operation of the windshield wipers.

10. Training of a Repair Technician

The technician shall be trained in accordance with this standard, with such training to include:

- Both active (hands-on) and passive coursework;
- Passage of both a written and practical exam;
- Adequate maintenance of records on all participants and their final exam scores.

11. Performance Requirements for Repair of Laminated Auto Glass

Repair of laminated auto glass is a permanent process that removes air from the break either by vacuum or displacement and results in the break being filled with a curable resin that approximates the refractive index, color and clarity of the laminated glass. To accomplish this, it is recommended that a windshield repair system include the following:

- A process to:
  - Inspect the damage and apply repair criteria;
  - Check for moisture and other visible contamination;
  - Ensure that the break is filled.

- Equipment to:
  - Remove moisture and other visible contamination;
  - Access the damage.
  - Remove or displace air and inject the repair resin.
  - Properly perform pit filling and resin curing processes.

- Resin that will:
  - Meet the manufacturer's requirements that are specific to the repair system's equipment such as viscosity, cure rate and ability to be polished;
  - In its cured state, approximate the refractive index, color and clarity of the laminated glass that is being repaired;
  - Minimize light refraction and seal the laminate in a crack;
  - Be recognized as conforming to this standard.

- To be recognized as conforming to this standard, the resin manufacturer shall be able to submit test results from an independent laboratory showing that resins meet the success criteria of the testing protocol as outlined in annex C, Test Protocol for Repair Systems.

Annex A
(normative)

Normative Bibliography

The following standards contain provisions which, through reference in this text, constitute provisions of this American National Standard. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

ASTM D1544-04, *Standard Test Method for Color of Transparent Liquids (Gardner Color Scale)*

ASTM D1003-07e1, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics*

AS/NZS 2366.2: 1999, *Windscreen repairs, repair systems* (Australian/New Zealand Standard

SAE Z26.1-1996, *Safety Glazing Materials for Glazing Motor Vehicles and Motor Vehicle Equipment Operating on Land Highways – Safety Standard*

NOTE: A normative annex is an integral part of a standard.

Annex B
(informative)

Informative Bibliography

ANSI/AGSC/AGRSS 005-2022, *Automotive Glass Replacement Safety Standard*
NOTE: Use only the most current edition of ANSI/AGSC/AGRSS.

AS/NZS 2366.1:1999, *Windscreen repairs, Part 1: Repair procedures*, Standards Australia/Standards New Zealand

BS AU 242:1998, *Automotive windscreen repair – Code of practice*, British Standards Institution (BSI)

BS AU 251:1994, *Specification for performance of automotive laminated windscreen repair systems*, British Standards Institution (BSI)

Recommended Practice for the Repair of Windshields, National Windshield Repair Division, Sept. 2002

Letter from Jacqueline Glassman, Chief Counsel for National Highway Traffic Safety Administration, dated July 7, 2004, to Leo Cyr. (Can be found at http://isearch.nhtsa.gov/files/Cyr.1.html.)

Annex C
(normative)

Test Protocol for Repair Systems

C.1 Purpose

The purpose of this test protocol is to evaluate, in various ways, repaired pieces of laminated glass with damage as described in clause C.3, Test Samples, in order to make a determination of the suitability for windshield repair, of the resins used to perform those repairs.

C.2 Normative References

See annex A.

C.3 Test Samples

C.3.1 Glass

Laminated AS-1 type, 0.03 in (0.76 mm) interlayer thickness and 0.2 in (5 mm) total thickness, 12 in (305 mm) square, unless otherwise specified

C.3.2 Resin

Only one repair resin may be submitted per test protocol. The pit resin used is considered to be part of this unique repair system, but the same pit resin may be used to certify multiple repair resins.

C.3.3 Repairs

C.3.3.1 Bullseye, star or combination break

- minimum diameter of 0.6 in (15 mm)
- maximum diameter as allowed in clause 6 of this standard
- repaired according to directions of that resin's seller
- located in geometric center of test glass, unless otherwise permitted or directed

C.3.3.2 Crack

C.3.3.2.1 For Repair Resins

At least a 4 inches x 12 inches (102 mm x 305 mm) test glass otherwise meeting the criteria of C.3.1, with a repaired crack running across the width and centered on the length.

C.3.3.2.2 For Crack Resins

A 12-inch (305-mm)-long test glass of width up to 6 inches (150 mm), and otherwise meeting the criteria of C.3.1. The repair shall be performed across that width and centered on the length.

C.4 Tests

C.4.1 Visual Appearance

C.4.1.1 Samples

Pull one sample of each type of repair at random from all samples that will undergo Accelerated Weathering, as described in annex D.

C.4.1.2 Method

C.4.1.2.1 Evaluate appearance in accordance with the criteria in clause 9 of this standard. However, repairs are to be inspected at a 45° angle. Also, examine the pit area (if applicable to that repair) and the rest of the repaired damage for the success criteria in C.4.1.3 below.

C.4.1.2.2 Perform Accelerated Weathering, as described in annex D, and then evaluate appearance again as in C.4.1.2.1.

C.4.1.2.3 These weathered samples may then be used for their specified purpose.

C.4.1.3 Expected Results

In addition to meeting the criteria of clause 9 of this standard, the pit resin (if applicable to that repair) shall not be delaminated or crazed. Yellowing of the pit resin beyond a Gardner Index of 5, as evaluated via ASTM D1544-04, *Standard Test Method for Color of Transparent Liquids (Gardner Color Scale)*, is not permitted. These pit evaluation criteria apply both before and after the samples have undergone Accelerated Weathering, as described in annex D. Also, no re-opening of the damage due to the exposure of Accelerated Weathering (annex D) is permitted.

C.4.1.4 Retesting

C.4.1.4.1 Unexposed Samples

If one test piece fails to conform to the criteria in C.4.1.3, pull another test piece of the same type and examine it to see if it meets the criteria of C.4.1.3. Repeat up to two more times, if necessary.

C.4.1.4.2 Exposed Samples

If one test piece fails to conform to C.4.1.3, resubmit up to three additional samples for retesting.

C.4.2 Impact Resistance by Ball-Drop

C.4.2.1 Samples

C.4.2.1.1 Use six samples of combination break repairs, as specified in C.3.3.1, to evaluate repair resins.

C.4.2.1.2 Use six samples of crack repairs, as specified in C.3.3.2, to evaluate crack resins.

C.4.2.2 Method

C.4.2.2.1 Subject three samples of each type to Accelerated Weathering (annex D).

C.4.2.2.2 Perform *Penetration Resistance, Test 26* from SAE Z26.1-1996, on all samples. Place the repaired side down (opposite the impacted side).

C.4.2.3 Expected Results

Success as specified in Test 26 of SAE Z26.1-1996, both before and after Accelerated Weathering (annex D).

C.4.2.4 Retesting

C.4.2.4.1 Unexposed Samples

If one test piece fails to conform to C.4.2.3, another set of three like samples shall be tested. This may be repeated for a maximum of three test rounds. If, in each round of tests, a sample fails to meet the success criteria, then the resin used is considered not to conform to the requirements of this test.

C.4.2.4.2 Exposed Samples

If one test piece fails to conform to C.4.2.3, another set of three like samples shall be subjected to Accelerated Weathering (annex D) and then tested. This may be repeated for a maximum of three test rounds. If, in each round of tests, a sample fails to meet the success criteria, then the resin used is considered not to conform to the requirements of the Impact Resistance by Ball-Drop Test (C.4.2).

C.4.3 Mechanical Strength by Three-Point Bend

C.4.3.1 Samples

C.4.3.1.1 Repair Resins

Use six samples of crack repairs, as specified in C.3.3.2.1, to evaluate repair resins.

C.4.3.1.2 Crack Resins

Use six samples of crack repairs, as specified in C.3.3.2.2, to evaluate crack resins.

C.4.3.2 Method

C.4.3.2.1 Subject three samples to Accelerated Weathering (annex D).

C.4.3.2.2 Perform Test A5.8, *Testing for the mechanical strength of a repaired crack*, from AS/NZS 2366.2:1999, on all samples.

C.4.3.3 Expected Results

These results apply to samples tested without or with Accelerated Weathering (annex D).

C.4.3.3.1 Repair Resins

Greater than 50% of the mean force required to produce cracks in undamaged test pieces;

C.4.3.3.2 Crack Resins

Greater than 70% of the mean force required to produce cracks in undamaged test pieces.

C.4.3.4 Retesting

C.4.3.4.1 Unexposed Samples

If one test piece fails to conform to C.4.3.3, another set of three like samples shall be tested. This may be repeated for a maximum of three test rounds. If, in each round of tests, a sample fails to meet the success criteria, then the resin used is considered not to conform to the requirements of the Mechanical Strength by Three-Point Bend Test (C.4.3).

C.4.3.4.2 Exposed Samples

If one test piece fails to conform to C.4.3.3, another set of three like samples shall be subjected to Accelerated Weathering (annex D) and then tested. This may be repeated for a maximum of three test rounds. If in each round of tests, a sample fails to meet the success criteria, then the resin used is considered not to conform to the requirements of the Mechanical Strength by Three-Point Bend Test (C.4.3).

C.4.4 Optical Properties Testing

C.4.4.1 Luminous Transmittance/Haze

Determines levels of loss of transparency due to repair’s presence

C.4.4.1.1 Samples

Samples may have more than one repair on the glass and more than one repair type on the glass. At least two repairs of each type shall be evaluated. Repairs shall otherwise meet the criteria of C.3.3.1.

C.4.4.1.2 Method

Perform this test in accordance with ASTM D1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics*. Perform the test before and after Accelerated Weathering (annex D).

C.4.4.1.3 Expected Results

All unexposed repairs shall retain 95% of the transmittance of undamaged glass. These same repairs shall not have haze more than 4 percentage units above that of the undamaged glass (e.g., if the undamaged glass has 0.5% haze, the repaired areas may not exceed 4.5% haze).

All exposed repairs shall have luminous transmittance of at least 75%.

C.4.4.1.4 Retesting

C.4.4.1.4.1 Unexposed Samples

If one test piece fails to conform to C.4.4.1.3, another set or test piece of like samples shall be tested. This may be repeated for a maximum of three test rounds. If, in each round of tests, a sample fails to meet the success criteria, then the resin used is considered not to conform to the requirements of the Luminous Transmittance/Haze Test (C.4.4.1).

C.4.4.1.4.2 Exposed Samples

If one test piece fails to conform to C.4.4.1.3, another set or test piece of like samples shall be subjected to Accelerated Weathering (annex D) and then tested. This may be repeated for a maximum of three test rounds. If, in each round of tests, a sample fails to meet the success criteria, then the resin used is considered not to conform to the requirements of the Luminous Transmittance/Haze Test (C.4.4.1).

C.4.4.2 Distortion/Deviation

Determines levels of light refraction or image distortion due to repair's presence

C.4.4.2.1 Samples

a) Repair Resins – Use two samples each of:
    - Bullseye repairs as specified in C.3.3.1
    - Star repairs as specified in C.3.3.1
    - Crack repairs as specified in C.3.3.2.1
b) Crack Resins – Use two samples of crack repairs as specified in C.3.3.2.2.

C.4.4.2.2 Method

SAE Z26.1-1996, *Optical Deviation and Visibility Distortion, Test 15*

C.4.4.2.3 Expected Results

Less than 2 minutes of arc shift in secondary image

C.4.4.2.4 Retesting

If one test piece fails to conform to C.4.4.2.3, another set of two like samples shall be tested. This may be repeated for a maximum of three test rounds. If, in each round of tests, a sample fails to meet the success criteria, then the resin used is considered not to conform to the requirements of the Distortion/Deviation Test (C.4.4.2) as regards that type of repair.

C.4.5 Resistance to Thermal Cycling

C.4.5.1 Samples

C.4.5.1.1 Repair Resins

Use three samples of combination break repairs, as specified in C.3.3.1, to evaluate repair resins. The legs of the combination breaks shall extend past the bullseye portion of the break.

C.4.5.1.2 Crack Resins

Use three samples of crack repairs, as specified in C.3.3.2.2, to evaluate crack resins, except that the crack length is only to extend about halfway across the sample glass, or about 6 inches (150 mm).

C.4.5.2 Method

C.4.5.2.1 Apparatus

a) Fixture for holding repaired samples over heat gun;
b) Heat gun capable of continuous temperature adjustment (such as Makita Model HG1100, or equivalent);
c) Freezer;
d) Probe- or thermocouple-type thermometer capable of reading at least 0°F (-18°C) to 300°F (150°C).

C.4.5.2.2 Procedure

a) Before starting the test, position the heat gun within the fixture so that the outlet is 2 inches (50 mm) directly below where the repair will be. Turn on the heat gun and adjust the thermostat until the exiting air temperature is a constant 225°F (107°C) at the spot where the air will impinge the bottom surface of the glass. If the heat-up time is more than 30 seconds, have the heat gun already running and equilibrated before the sample is placed over it.
b) Place the first repaired sample in freezer set to 0°F (-18°C) and allow to equilibrate for one hour.
c) Remove the sample from the freezer and make a quick check of its repair condition. If this is acceptable, place the sample on the fixture, repair side up.

Affix the temperature probe or thermocouple wire to the top of the sample over the center of the repair.

d) Allow the heat gun to heat the underside of the glass directly under the repair until the repair side reaches 150°F (66°C). Remove the sample and allow it to cool to 100°F (38°C). As it is cooling, examine it for any of the failure criteria described in C.4.5.3, Expected Results.
e) If the sample has not failed, repeat the freezer/heat gun cycling up to two more times
f) Repeat steps (a) – (e) on the other two repaired samples.

C.4.5.3 Expected Results

In addition to meeting the criteria of clause 9 of this standard, the repair should remain unchanged. The star portion shall not separate from the glass or the PVB. No voids shall appear in the bullseye.

C.4.5.4 Retesting

If one test piece fails to conform to C.4.5.3, another set of three like samples shall be tested. This may be repeated for a maximum of three test rounds. If in each round of tests, a sample fails to meet the success criteria, then the resin used is considered not to conform to the requirements of Resistance to Thermal Cycling Test (C.4.5) as regards that type of repair.

Annex D
(normative)

Accelerated Weathering

D.1 Samples

Perform on all samples for which pre-test accelerated weathering is prescribed. At least two samples of each type shall ultimately be tested.

D.2 Method

D.2.1 Irradiance

UVA 340 bulb, or equivalent

D.2.2 Cycle

8 hours UV plus condensation at 140°F (60°C)
4 hours condensation at 122°F (50°C)

D.2.3 Total Cycle Time

500 hours

D.3. Expected Results

See the various “Expected Results” clauses in this standard.

Annex E
(informative)

Typical Portrayal of Windshield Damage

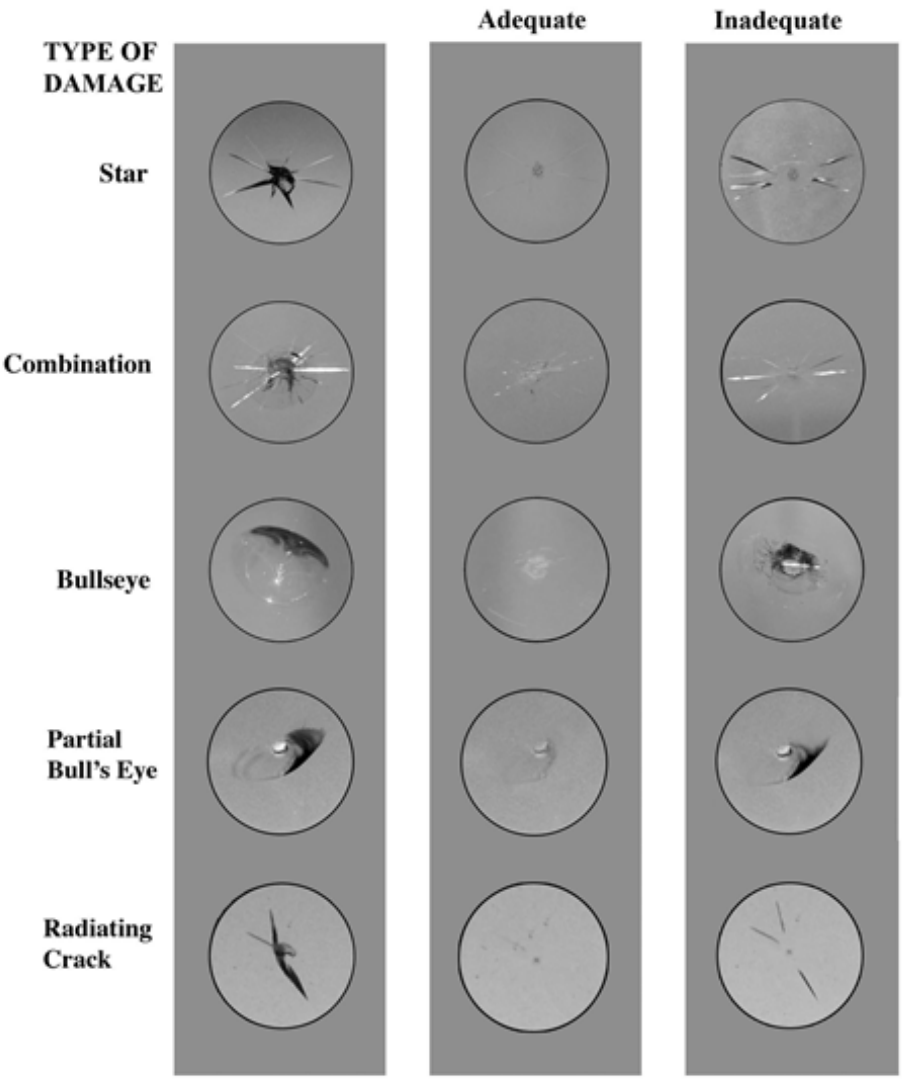

Figure E.1 – Quick Reference of Typical Repairs

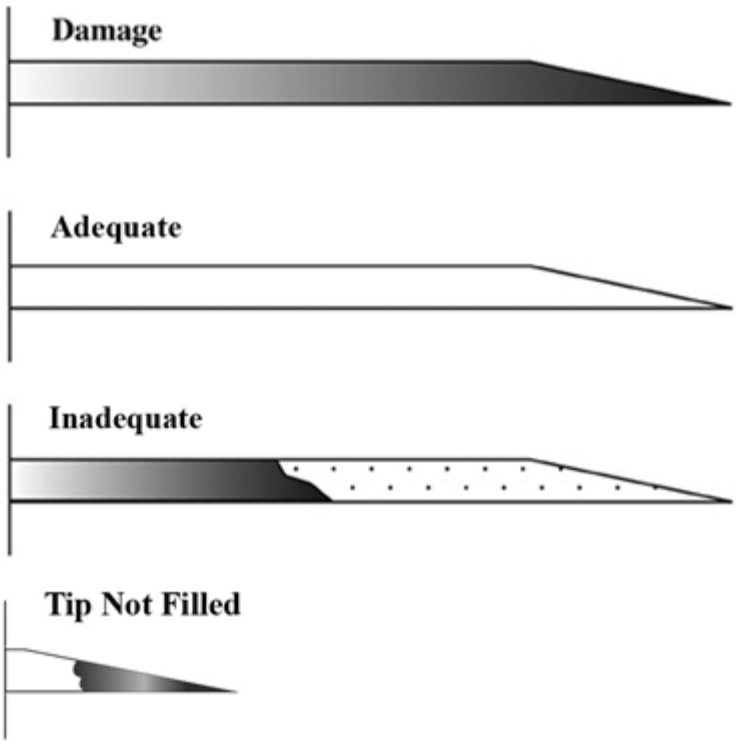

Figure E.2 – Adequate and Inadequate Crack Repair