Instructions for

Graphic Removal, Surface Preparation and Application of Graphics on Rail Transport Vehicles

Description

This bulletin gives 3M's recommended guidelines for removal of damaged graphics, surface preparation and graphic application specifically for rail transport vehicles.

It should be used in conjunction with Instruction Bulletins 5.4 and 5.5, which cover graphic application and 6.5 which covers removal.

Guidelines for Removal of Films

⚠ CAUTION Removing graphics from substrate that were not in good condition at the time of application may result in substrate damage.

Heating a graphic eases removal of any film, as the heat softens the adhesive, reducing the pull-off force needed.

For most situations, almost any heat source that can raise the applied graphic temperature to 72°C to 93°C (160°F to 200°F) can be used.

Common sources include heat lamps, industrial heat guns, steamers and hand torches.

Use care not to scorch, burn or otherwise damage the film or substrate when using heat.

⚠ Caution
When using any equipment, always follow the manufacturers' instructions for safe operation.

Procedure for Removing Damaged Graphic Panels

1. Lightly cut the film along the top-line of the panel overlap, with a scalpel, for the area being removed. Note: When cutting onto the substrate, take care to ensure that cut is through film layers only and there is no damage caused to the surface of the substrate or paint finish.

2. Once the area is ready for removal using heat, follow the procedure outlined in page 6 of Instruction Bulletin 6.5, "Removal Methods".
3. Clean the substrate by solvent wiping with Isopropyl alcohol.
4. Depending on the condition of the underlying materials, paint or filler may be pulled-off during the removal process.
5. If the paint surface is damaged, resurfacing treatment must be carried out prior to graphic application.

Procedure for Graphic Repair

Sometimes graphic damage can be repaired; however, repaired graphics are not warranted. These procedures are for information only.

Damage to Face of Graphic

1. Trim loose areas of film before patching. Take care to ensure no damage is caused to the surface of the substrate or paint finish.

2. Clean the area by wiping with isopropyl alcohol.

3. Cut the film patches so they overlap all sides of the damaged area by at least 6 mm (1/4 inch). The minimum size of the patch should be 50mm x 50mm.

4. Position the patch over the damaged area.

5. Hold in place at the top with a strip of Scotch™ Masking Tape.

6. Remove the paper liner.

7. Squeegee firmly into place using a plastic applicator.

8. Use heat such as from a heat gun to heat all edges of the patch, and then re-squeegee all edges.

Substrate Requirements

A great deal of time and effort goes into designing and making a graphic. The first step to obtaining a high-quality, long-lasting graphic is to use the proper preparation and application techniques for each type of substrate.

Films and sheetings can be applied to most substrates that are:

- Clean. All substrates must be considered contaminated and must be cleaned prior to application of film or sheeting, with the last cleaning step being done *immediately* before application. Even a freshly painted substrate can collect dust before graphics can be applied.

- Dry. Any moisture trapped beneath the graphic will cause the graphic to fail prematurely. Moisture prevents the adhesive from adhering correctly, can cause bubbles, and can freeze in cold environments.

  Moisture results from:

  - Inadequate drying after cleaning as well as from application solutions.
  - Failure to pre-dry some substrates such as polycarbonate sheeting.
  - Condensation at low temperatures.
  - High humidity environments.

It is impossible to keep the substrate dry if there is condensation or high humidity.

Because of the difficulty removing all of the moisture, wet application methods are not recommended. Moisture is also difficult to remove from beneath 3M™ Controltac™ *Plus* Films and 3M™ Scotchlite™ *Plus* Sheetings or 3M Graphic Films with 3M™ Comply™ Performance.

- Relatively non-porous. Porous materials absorb moisture which affects the ability of the film or sheeting to adhere to the surface.

- Smooth. It is more difficult for the adhesive to make good contact with textured surfaces if the roughness is greater than that of 150 grit sandpaper. Refer to Instruction Bulletin 5.5, *General Procedures for Interior and Exterior Dry Applications,* for application techniques to rough surfaces.

Substrates

Metals

Any painted surface with bare metal or rust spots should be entirely resurfaced as recommended for the following metals.

Aluminium

For the best results, use etched and degreased aluminium or anodized aluminium.

Clean the surface (See appendix II). Use
- METHOD 3: Isopropyl Alcohol Cleaning.

For other types of aluminium, follow these additional procedures prior to cleaning.

Badly Pitted or Oxidized Substrate

Use a commercial acid-brightener.

Uncoated and Unetched

1. Remove white rust (oxidation).
2. Smooth with 100 grit or finer abrasive.
3. Degrease and etch or degrease and prepare with an amorphous chromate or non-chrome conversion coating.

Conversion Coated

1. Remove white rust (oxidation).
2. Be sure that coating adheres tightly to the aluminum and is free of any powdery residue.
3. Coating should meet these requirements:

Chromate
   ASTM B 449, Class 2.

Non-chromate
   ASTM B 449, Class 1.

Air-dried, acrylic on non-chrome coated
ASTM D 3359 for tape snap adhesion
ASTM D 4541 for adhesion the same as a chromate-coated aluminium of the same alloy.

Steel

Do not apply film directly to unpainted steel. Any painted surface with bare metal or rust spots should be entirely refinished. After painting, follow preparation recommendations found in the Painted or Primed Substrates, page 3.

Untreated

1. Contact metal treatment suppliers for recommendations on treatment and finishing.
2. Prime and paint.

Electro-Galvanized

Follow the recommendations for untreated.

- Zinc electroplated
- Cold rolled
- Hot rolled pickled
- Black iron

Phosphate-Coated Galvanized

1. Remove white rust (oxidation) with a 3M™ Scotch-Brite™ Cleaning Pad.
2. Rinse with water and dry. All water must be removed.
3. Check for moisture by applying a piece of film to the steel. Bake it in a 300°F (149°C) oven for 5 minutes. Check for blisters in the film.
4. Prime and paint.

Rusted

1. Abrade the substrate lightly with a right angle grinder or random orbital sander. Use a 3M™ Scotch-Brite™ Surface Conditioning Disc (super fine-gray) of appropriate size or 3M™ Scotch-Brite™ Heavy Duty Cleaning Pad with 3M™ Insta-Lok™ Hand Block.

2. Clean the surface. Use:

   - METHOD 3: Isopropyl Alcohol Cleaning.

3. Test the cleaned substrate by wiping with a clean paper towel.

4. Repeat the IPA wipe if there is any evidence of dust or solvent film.

5. Prime and paint. Apply a fast-dry paint to any areas that have been abraded down to bare metal.

Painted or Primed Substrates

All surface treatments, primers and topcoats must adhere well to the base material. If the paint is not firmly attached to the base material, the graphic and the paint may pull away from the substrate. Any visible signs of peeling, lifting, or bubbling of the paint indicates poor paint-to-substrate adhesion. Original paint may not have adequate adhesion to some substrates. Even removing changeable films may pull off paint that is not firmly attached to the base material.

- Avoid finish paints that tend to chalk. Chalked paint on weathered surfaces must be removed by mechanical buffing. Chalked paint that is on the interior must be re-primed.
- Test for chalking with the Tape Snap Test, see Appendix I.
- Be aware that some tinted paints may bleed through some films or sheetings.
- Be aware that some graphic materials may bleed through onto the paint.
- Avoid paints that contain migratory agents or agents that are difficult to adhere to. Some paints, especially those sold as graffiti-resistant, may contain ingredients such as silicones, chlorinated waxes, or other ingredients in relatively high amounts. It may not be possible to obtain adequate adhesion to these types of paint.
- Follow the drying and curing times recommended by the paint manufacturer. Under-cured paint may outgas, prevent the adhesive from adhering adequately, or prevent a removable or changeable product from removing as expected.

- The primer and the paint should be produced by the same manufacturer and formulated as companion products to ensure good adhesion between the paint layers.

Abrading painted surfaces with some abrasive discs can result in anti-blocking agents from the disc remaining on the surface. This can result in reduced adhesion levels when applying graphics. For this reason abrasive discs that contain stearate and other anti-blocking agents should not be used to prepare surfaces for subsequent graphic application.

Note: METHODS for cleaning are in Appendix II.

Common Types of Paint

Baked Enamel Paint

These are the easiest paint systems to manage.

1. Bake according to the manufacturer's recommendations and cool to room temperature.

2. Clean the surface. Use:

   - METHOD 1: General Cleaning, then
   - METHOD 2: Solvent Cleaning.

Latex Paint

High quality gloss or semi-gloss paints provide the best application surface.

Low luster or matte paints contain matting agents that may contribute to poor film adhesion.

Some formulations do not allow films to adhere well. Paint testing is available from 3M. Call Technical Service at 01344 858000 for information.

Although most paints are usually dry to the touch within one hour, you cannot apply the graphic immediately after painting. Paint manufacturers typically recommend waiting one week. Even latex paint contains solvents that continue to evaporate for a period of time. If the paint is not thoroughly cured, the graphic may not adhere or its edges may curl. If you must apply the graphic sooner, perform the Tape Snap Test in several places to ensure adequate dryness. See Appendix I.

Clean the surface. Use:

- METHOD 1: General Cleaning.

Oil-based or Enamel Paint

Clean the surface. Use:

- METHOD 1: General Cleaning.

Two-part Urethane Paint

Two-part urethane paints must be cured before applying a graphic. If the paint has not thoroughly cured, bubbles will form under the applied graphic. Follow the recommendations of the paint manufacturer.

As a general guideline, proper curing requires temperatures above 21°C (70 F) for 5 to 7 days, depending on paint thickness and temperature. This type of paint does not cure at temperatures below 9°C (50 F).

1. Test for outgassing. See Appendix I.
2. Clean the surface. Use:
   - METHOD 1: General Cleaning, then
   - METHOD 2: Solvent Cleaning.

Powder-coated Paint

These paint systems are available in a wide variety of formulations. Some formulations do not allow films to adhere well. Paint testing is available from 3M. Call Technical Service at 01344 857850 for information.

Clean the surface. Use:

- METHOD 1: General Cleaning, then
- METHOD 2: Solvent Cleaning.

Textured Paints

1. Clean the surface. Use:
   - METHOD 1: General Cleaning.
2. Test for substrate integrity with the Tape Snap Test, See Appendix I..
3. If any dust comes off on the tape, clean the surface again.

PRE-APPLICATION INFORMATION

Temperature & Environment

Apply graphics when the air, film and substrate temperatures are within the range specified in each film's Product Bulletin. Differences in temperature between ambient air, substrate and graphic film could lead to surface moisture which could affect the adhesive bond of the graphic to the substrate. To enable a successful application in the most efficient manner with the minimum of difficulty it is important that the application of graphics is carried out in a dry enclosed environment with a minimum ambient temperature of 12°C. The incorrect temperature may prevent the film from performing as expected.

Conditions that Affect Graphic Application

- Graphics applied above the maximum recommended application temperature may pre-adhere.
- Above the maximum recommended application temperature, graphics constructed of Controltac *Plus* films may lose their positionability feature.
- The temperature of the substrate must be above the dew point to prevent moisture from condensing on the surface.
- In very humid conditions, it may be difficult to keep the substrate dry.
- Below the minimum recommended application temperatures, films and sheetings become stiff and brittle. The adhesive cannot bond adequately with the substrate. In addition, 3M™ Controltac™ *Plus* Films can trap air and cause bubbling.
- Substrates may be heated in order to raise the surface temperature above the minimum specified. Use an appropriate portable heater or heat lamps.

General Application

- Replace the plastic applicator if the edges become nicked or ragged. Damaged edges leave bubbles and scratch the graphic.
- If the graphic does not have an application tape, use a low friction sleeve on the applicator to minimise scratching the graphic.
- A smooth substrate is the most ideal application surface. However, many surfaces that appear smooth may actually be irregular or uneven. Therefore it is most important that sufficient pressure is used evenly on the complete surface, including on any bodywork creases and dents, during the application, to ensure that complete adhesion of the graphic surface is achieved.

Registering the Graphic

Mark on the substrate the exact location of the top and sides of the graphic with masking tape, a lead pencil, or marking pen. Do not use a chalk line, china marker or grease pencil, which will contaminate the adhesive and cause edge failure.

Graphic Placement

Proper placement of the graphic can make the job easier. To minimise application problems, follow these guidelines for positioning the graphic.

Note: If you lay the graphic on the floor, it will pick up dirt on the back and transfer it to your clean substrate.

- Test your layout by temporarily positioning the graphic on the substrate. Use masking tape to hold it in place. This ensures that the graphic will fit and all the pieces are available.
- Position the graphic to minimise the number of rivets and substrate seams that will be covered. Moving the graphic just 2.5 to 5 cm (1 to 2 inches) may avoid a row of rivets.
- If there are rivets, position the graphic so the film extends at least 1.3cm (½ inch) past the rivet and covers as many rivets as possible. This eliminates the need to cut around the rivets.
- Do not allow the edge of a graphic to fall on rivets.
- If the film covers seams in the substrate, you will need to cut through the film as described in Substrate Seams on Instruction Bulletin 5.5 page 12.
- Grasping the edge of the film may transfer body oils and dirt to the adhesive. To minimise any problems with adhesion at those points, grasp the film as far into graphic as possible without wrinkling the film.

Removing the Adhesive's Liner

1. Lay the graphic liner side up against a flat, clean surface.

2. Flick a corner of the film with your finger or bend the corner to separate the liner from the adhesive. If the liner is scored, bend at the score.

3. Remove only as much liner as required for your application method. The procedure for removing the liner, whether just a small section, or the entire liner is to pull it away from the graphic at a 180 degree angle with a smooth continuous motion. See Figure 1.

   Note: Always remove the liner from the graphic rather than the graphic from the liner. This method:

- Helps ensure that the tape removes any Prespaced graphics from the liner.
- It minimises stretching or wrinkling of the graphic

Using Heat During Application

Heat is required during some application steps. Most films withstand a moderate amount of heat. However, films designated "e-film" are more sensitive and can dull or curl if too much heat is used.

⚠ Caution
Heat or open flames may contribute to a flash fire or burns. Follow these precautions when using a heat source for flame treating.   • Read and follow the instructions supplied with the heat source. • Avoid personal contact with the heat source. Wear heat-resistant gloves and safety glasses. • Do not use heat sources near solvent mixtures or residues, or where solvent vapors may be present.

Making Film Overlaps - Exterior Only

Environmental conditions such as wind, rain, and blowing debris stress the overlapped edges of graphics. Use careful planning for both vertical and horizontal film overlaps to reduce the stress and damage.

Note: Overlaps greater than 13 mm (½ inch) may contribute to edge lifting.

Vertical Film Overlaps

Any overlaps on films applied vertically should face away from the front of the vehicle where possible. Apply the first piece of film at the rear of the vehicle. Work around to the front, overlapping each additional piece by 6 to 13mm (¼ to ½ inch), but no more than that. Repeat for the other side, again starting from the back.

Horizontal Film Overlaps

Apply the lower piece of film first. Work toward the top, overlapping each subsequent piece 6 to 13mm (¼ to ½ inch), but no more than that.

Edge Sealing

Graphics on rail rolling stock and locomotives do not necessarily require edge sealing, unless they are protected with Scotchgard® Graphic and Surface Protection Film 8993, but it may help keep the edges from lifting when they are subjected to external factors such as:

- Exposure to wind from high speed travel.
- Exposure to physical abrasion.
- Exposure to high-pressure wash.

Note: Method for edge sealing is given in Appendix III.

3M Related Literature

Listed below is related 3M technical literature that may be of interest.

Subject	Bulletin No.
Product Bulletins	
Film or Sheeting	Same as film or sheeting
Instruction Bulletins	
Application: Substrate Selection, Preparation and Substrate-specific Application Techniques	5.1
Application: Special Applications and Vehicles	5.4
Application: General Procedures for Interior and Exterior dry Applications	5.5
Storage, Handling, Maintenance, Removal	6.5

Health & Safety

Refer to the package label and the Material Safety Data Sheet for health, safety, and handling information on the products referenced in this bulletin. For 3M products, if necessary, you may contact our Toxicology/Product Responsibility Department on 01344 858000.

Important Notice to Purchaser

The 3M products described in this publication are covered by a 3M warranty and limitation of liability.

3M's warranty provides that if 3M finds that goods are defective in material or workmanship they will be replaced or the price refunded at 3M's option but note that 3M does not accept liability for other direct losses (except for personal injury or death) or consequential losses relating to defective products or from information supplied by 3M. Purchasers and users of 3M products, and not 3M supplying companies, are always solely responsible for deciding on the suitability of the 3M product for their required or intended use.

Appendix I
Substrate Testing

Outgassing Test

3M assumes no liability for bubbling of films or sheetings due to outgassing

1. Apply a 135 by 135 cm (5 by 5 inch) piece of polyester film or the film or sheeting used to make the graphic. Films vary in their ability to allow the gas to escape. Use sheeting 690 or polyester for greatest assurance that the substrate will not outgas.

2. Wait for 24 hours or, if possible, oven bake for 2 hours at 65°C (150°F) or 5 minutes at 176°C (350°F).

3. If bubbles appear under the film, the substrate is outgassing.

4. If the paint or substrate outgasses, wait 24 hours and test again. Continue to apply test pieces until the substrate no longer outgasses. If the substrate continues to outgas, contact the substrate manufacturer for assistance.

Tape Snap Test

Because substrates vary, this test is only an indicator of general surface characteristics. It may not be indicative of the entire area.

1. Using 3M™ Plastic Applicator PA-1, firmly apply a 25mm strip of aggressive, pressure-sensitive tape (Scotch® Tape #610) over the area.

Note: Plastic applicator PA-1 is available from 3M Commercial Graphics Division. Tape 610 is available through most film or tape distributors.

2. Remove the tape by pulling it back upon itself at a 135° angle using a rapid, firm pull. See Figure 1.
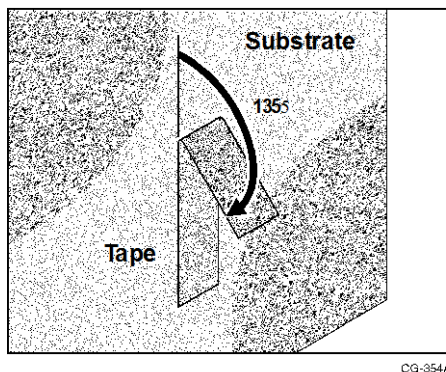

Figure 1. Pull Off Tape at a 135° Angle

3. No separation should occur between the top coating and the layers underneath. No paint or chalking should be present on the tape.
4. If separation occurs, removal without damage is not warranted for removable or changeable products.

Contaminant Tape Test

Because the degree of substrate contamination by paint dust may vary, this test is only an indicator of general surface condition. It may not be indicative of the entire area.

1. Using 3M™ Plastic Applicator PA-1, firmly apply a 25mm x 50mm long strip of aggressive, pressure-sensitive tape (Scotch® Tape #610) on the area to be tested.

2. After 5-10 seconds remove the tape by pulling it back at a 90° to135° angle using a firm pull.

3. No evidence of a difference in the taped area to the surrounding surface should be visible and no contamination should be present on the tape.

3. If there is evidence of a visual difference or contamination present on the tape, the area should be solvent wiped again.

Appendix II

Cleaning Methods

⚠ Caution	⚠ Caution
Before handling any chemical products, always read the container label and the MSDS.	When using any equipment, always follow the manufacturers' instructions for safe operation.

There are three basic cleaning methods: General Cleaning, Solvent Cleaning and Isopropyl Alcohol Cleaning. The type of substrate determines which procedure to use.

The use of improper cleaning methods and techniques before applying the film voids the warranty.

Always test cleaners in an inconspicuous area before using. Some cleaners may dull your substrate or leave contaminants on it. Lower solvent content cleaners may not clean the type of contaminants you have.

METHOD 1: General Cleaning

1. Clean the substrate immediately before applying film. Dust and other contaminants can collect quickly on the substrate and prevent the film from adhering properly.

2. Use detergent and water to clean the substrate.

   - For most surfaces, interior or exterior: Wash the substrate with 1 ounce of synthetic detergent per gallon of lukewarm water. Avoid soaps or preparations that contain waxes, oils or lotions. Be aware that some window cleaners contain waxes.

   - Be aware that the chemicals used in some automated vehicle washing equipment may interfere with adhesion.

   - For interior walls where grease and/or oil is present on the substrate: Wash the substrate with a solution of TSP (trisodium phosphate) and lukewarm water. Prepare the solution according to the manufacturer's written instructions.

3. Dry thoroughly with clean, lint-free paper towels.

METHOD 2: Solvent Cleaning

The following list of cleaners is provided for your convenience; other acceptable cleaners may be available. 3M does not endorse any particular chemical manufacturer or supplier.

✓Important Note

Local air quality regulations may regulate or prohibit the use of surface preparation and cleaning materials based on solvent (VOC) content. Consult your local air quality regulations.

Lower Solvent Content Cleaners
- 3M Prep Solvent-70, 8983*

Petroleum Distillate-based Cleaners
- 3M™ Adhesive Cleaner and Wax Remover 8984*
- 3M Surface Preparation System*
- DuPont Prep-Sol™ Solvent Cleaner 3919S**
- Sherwin Williams R7K156 Sher-Will-Clean™**
- Sherwin Williams R7K158 Sher-Will-Clean™**
- Xylol, lacquer thinner, or VM&P Naphtha***

   * *Available from 3M Commercial Graphics Division.*
   ** *Available from automobile supply houses handling DuPont or Sherwin Williams products.*
   *** *Available from chemical companies listed under "Solvents" in the Yellow Pages. If these are not available locally in small quantities, they may be obtained from mail order chemical firms, such as E. H. Sargent and Co. and Fisher Scientific.*

Procedure

1. Saturate a clean lint-free paper towel with a solvent and thoroughly wipe the substrate.

2. Wipe with a second paper towel before the solvent evaporates from the substrate. As the paper towel becomes dirty, discard it. A dirty towel just moves the dirt around, not remove it.

3. Make sure the substrate is completely dry. If necessary, use a heat gun to dry any retained liquid.

4. Apply the graphic immediately. Dust and contaminants prevent the adhesive from performing as expected.

METHOD 3:   Isopropyl Alcohol Cleaning

Note: Because it evaporates quickly, IPA (isopropyl alcohol) is not an appropriate cleaner if the substrate is warm or the conditions are windy. In such conditions, use the General Cleaning Method.

1. Saturate a clean lint-free paper towel with with isopropyl alcohol (IPA)* and thoroughly wipe the substrate.

2. Wipe with a second paper towel before the IPA evaporates from the substrate. As the paper towel becomes dirty, discard it. A dirty towel just moves the dirt around, not remove it.

3. Make sure the substrate is completely dry. If necessary, use a heat gun to dry out any liquid retained in the seams.

4. Apply the graphic immediately. Dust and contaminants prevent the adhesive from performing as expected.

   *Available from 3M as 3M VHB™ Surface Cleaner

IMPORTANT NOTE

Flatting down of paint.

After abrading painted surfaces with abrasive discs paint dust can be held in the grooves of the abraded surface. This can result in reduced adhesion levels when applying graphics. Thorough and possibly repeated solvent wiping is required to remove these 'contaminants' to ensure proper adhesion levels are achieved. (See Cleaning Methods.)

The wiped surface should appear uniform in colour after wiping and drying. To also test for removal of dust contaminants carry out 'Contaminant Tape Test' as detailed in Appendix 1, Substrate Testing.

Appendix III

Edge Sealing

⚠ Caution
Before handling any chemical products, always read the container label and the MSDS.

Note: If you use high pressure to wash a graphic, even if the edges are sealed, the warranty may be voided if you exceed the pressure washing recommendations in Instruction Bulletin 6.5.

Graphics protected with

Scotchgard® Graphic and Surface Protection Film 8993

All edges and overlaps that are not horizontal must be edge sealed with 10-12mm wide Scotchcal ElectroCut Graphic Film Series100-114.

Fuel Spillage

Edge sealing is required when sheeting is used in fuel spill areas.

Types of Edge Sealer

When in doubt, check the film Product Bulletin for the appropriate edge sealer. General guidelines, below:

Type of 3M Films	3M Edge Sealer	Minimum Temperature
Typical PVC films	3950	10°C
Scotchgard® Graphic and Surface Protection Film 8993	100-114	4°C
Reflective sheeting	4433	13°C

How To Apply Liquid Edge Sealer

1. Do not apply edge sealer unless the temperature is within the recommended temperature range.

2. Remove the application tape and re-squeegee the edges before applying the edge sealer.

3. Use the felt dauber supplied with edge sealer or a 0.6cm (1/4 inch) brush.

4. Wipe any excess edge sealer off the dauber or brush.

5. Hold the brush or the flat edge of the dauber so that it straddles the film and substrate

6. Pull the dauber or brush along the edge in a smooth, continuous motion. Make sure the entire edge is covered with no gaps.

Storing Edge Sealer 4433

- Edge sealer 4433 is a two-part system. It must be used immediately after mixing.
- Tightly seal the cap of the edge sealer container.
- Store in a cool, dry place.
- Use within 1 year of purchase.