COMPOSITE MATERIALS
HEALTH AND SAFETY RULES FOR COMPOSITES

A. Before using any composite material, read the health and safety rules found under the PANEL SEALING AND BONDING and the PRODUCTS AND TOOLS headings of this section.

B. When sanding or cutting these materials, always wear a dust mask and safety glasses. Wherever possible, dust should be removed at source by a suitable ventilation system.

C. When handling panels, avoid touching the surface of the laminated side with bare hands as much as possible. This side is rough and may contain some glass projections and slivers.

D. When making repairs with resins or polyester sealer, the following precautions must be observed:

   a) Wear rubber or nitrile gloves, safety glasses, a dust mask, and protective clothing.

   b) Dispose of waste according to the relevant standards. Never dispose of liquid resin or solvent wastes by pouring them down the drain; use the services of qualified waste treatment companies.

   c) Do not place resins in contact with a heat source or open flame.

   d) Do not smoke while handling hardeners or liquid resins.

   e) Ensure portable fire extinguishers are close at hand.

   f) Do not replace the containers.

   g) Order and stock only the minimum quantities needed.

   h) Use the recommended hardeners (in specified proportions).

   i) Work in a well-ventilated area.

   j) Use resins already containing accelerators added by supplier.

   k) Read the Material Safety Data Sheet (MSDS) for all products used.
Figure 1 - Exterior Covering
GENERAL DESCRIPTION

The chassis of the Nova LFS bus is covered with various composite materials. The thermoplastic skirts — or grey panels (Triax) — are made of polycarbonate. However, the material that is most used on these vehicles is molded glass/polyester. See the GLASS/POLYESTER COMPOSITE heading of this section for more information.

The composite panels are mechanically bonded to the chassis with glue. Therefore, it is extremely important to be aware of the basic techniques of bonding and sealing, in order to replace a composite panel properly on the vehicle. See the PANEL BONDING AND SEALING heading in this section for more information on these techniques.

NOTE:
The warnings and safety rules recommended in this section must always be respected when performing any operation on composite materials.

GLASS/POLYESTER COMPOSITE

DESCRIPTION

Molded glass/polyester makes it possible to obtain thin and light parts, both structurally sound and esthetic. They are practically impermeable to water, calcium, oils, and petroleum products, thereby ensuring the vehicle’s longevity and reliability. Glass/polyester composite panels are used on Nova LFS vehicles in the following locations:

EXTERIOR MOLDED COVERING

See Figure 1.
- Front shell
- Rear shell
- Side panels
- Roof panels
- Air conditioning/heating module

INTERIOR MOLDED COVERING

- Wheel housing
- Dashboard

COMPOSITION

See Figure 2.

The resins are made from an unsaturated polyester resin and contain either cut or continuous glass reinforcement fibers.

The resin is made from unsaturated polyester in solution in a styrene monomer. The base is either orthophthalate and/or orthophthalate/diphthalate.

At the time of molding, the resin and the fibers are deposited simultaneously against the surface of the mold, of which they take the form. Chemical additives, added to the liquid resin right before the molding, ensure polymerization and hardening.

The glass/polyester panels used on the vehicle typically include the following components:
- An exterior finish made of colored gelcoat.
- A structural portion made of a glass/polyester laminate.
- Metal inserts for anchoring or screwing accessories are embedded in the laminate, where required.

POLYESTER GELCOAT

The surface coat of the glass/polyester composite laminate is a heavily charged, UV-stabilized, colored polyester resin. This coat, with a nominal thickness of 0.02 in (0.5 mm), is what gives the panel its attractive, colored external finish and protects it from the weather.

NOTE:
The gelcoat finish on certain panels may be painted. When making a repair, check visually or by scratching the surface whether the gelcoat panel has been painted over. This is easily done, as the paint coating is very thin compared to the gelcoat.

NOTE:
Due to the properties and abrasive effect of paint thinner on gelcoat, NEVER use it to clean gelcoat-finished components.

Figure 2 - Panel Made of Composite Materials
ACCELERATOR HARDENER SYSTEM

To ensure that the polyester resin polymerizes and hardens, a combination of a methyl ethyl ketone peroxide (MEKP) based hardener and a cobalt naphthalene-based accelerator is used. The accelerator is already present in the formulation of the base resin, while the hardener is only added at the time of molding.

ADDITIVES

In certain cases, such as when resins must meet specific fire standards, additives (aluminum trihydrate, for example) can be added to the liquid resin. When combustion occurs, these additives release water molecules during an endothermic reaction, which have the effect of halting combustion.

GLASS REINFORCEMENT

Cut Filament Glass Cloth

This cut filament glass cloth (mat) resembles felt made of glass fibers cut to about 1 to 2 in (25 to 50 mm) in length, held together by means of a binding compound. The glass mat is usually available in weights of 1, 1.5 or 2 oz/ft² (300, 450 or 600 g/m²). The mat is isotropic, meaning that the fibers are distributed uniformly in all directions in the cloth, providing balanced mechanical properties.

Continuous Fiber

Continuous glass fiber can be cut into the mix when projected onto the mold, forming a reinforcing coat with the same properties as those of cloth mat.

Intersecting or Unidirectional Cloth

Continuous fiber can be woven or mechanically bonded to create reinforcing cloth. The orientation of the reinforcement provides increased mechanical resistance along the fiber axis. These cloths are used only in certain specific applications and are usually employed in combination with mats.

MISCELLANEOUS MATERIALS

In specific applications, cores of PVC foam or balsa wood can be used to produce sandwich laminate sections. This configuration increases the rigidity of the panel.

Metal inserts can also be embedded in the laminate coats as anchoring or attachment points.

MOLDING PROCESS

CONTACT MOLDING

An initial coat of gelcoat, approximately 0.02 in (0.5 mm) thick, is applied to an open mold coated with a release agent.

The gelcoat, under the action of the MEKP hardener added during the application, takes about 30 to 60 minutes to harden.

After the gelcoat is polymerized, coats of resin-saturated glass cloth, to which hardener has been added, are placed in layers in the mold; bubbles are removed manually to perfectly shape the cloths to the form of the mold.

Cut glass cloth or intersecting cloth can be used in the laminate. Coats are applied in the specified number and sequence. See Figure 3.

After 30 to 60 minutes, the coats of resin-saturated cloth polymerize and harden to form a solid sheet.

The panel is then released from the mold. The gelcoat stays tightly bonded to the laminate.

The subsequent operations consist of cutting the borders of the laminate to give the panel its final shape, piercing holes, and making cutouts.

If required, the gelcoat surface can be polished, and if minor imperfections are detected, they can be corrected.

PROJECTION MOLDING

This technique is essentially similar to that described above for contact molding, except that the glass fiber is projected against the surface at the same time as the resin, and not laminated as a cloth. See Figures 3 and 4.
Using this method, larger surfaces can be constructed while eliminating the cloth template cutting operations and reducing cloth template overlaps.

CAUTION:
Please note that you must use an aerobic type gelcoat, i.e. gelcoat that cures in the presence of oxygen. This is similar to the type used on boat hulls.

TYPICAL PERFORMANCE OF GLASS/POLYESTER COMPOSITES

Glass/polyester-based composites are thermohardened plastics, and therefore do not soften with heat.

TABLE OF PROPERTIES

NOTE:
These nominal data are given for reference only.

PHYSICAL PROPERTIES

Glass/polyester density ................................................ 1.7
Tensile strength ......................................................... 11 psi (75 kPa)
Modular strength ...................................................... 798 psi (5500 kPa)
Flex resistance .......................................................... 20 psi (135 kPa)
Modular flex ......................................................... 725 psi (5000 kPa)
Temperature (maximum continuous) ........180 °F (82 °C)
Barcol hardness (minimum) ........................................ 35

FIRE RESISTANCE
1. Composites used must meet FMVSS-302 standards.
2. In certain cases, when specified by the client, composites can be formulated to meet the following standards:
   • Fire resistance rating in accordance with ASTM E-162 – Iₙ ≤ 35.
   • Smoke emission in accordance with ASTM E-662 – Dₙ (1.5) ≤ 100; Dₙ (4.0) ≤ 200.

PANEL BONDING AND SEALING

HEALTH AND SAFETY RULES RELATED TO PANEL BONDING AND SEALING

WARNING:
Before proceeding with any bonding or sealing operation, read the health and safety rules found in the COMPOSITE MATERIALS and the PRODUCTS AND TOOLS headings of this section.

A. The thickness of the glue between two assembled panels (in final position) must be of at least 0.1 in (2.5 mm).

This minimum thickness ensures the flexibility of the assembly, enabling it to handle stresses that tend to deform it. In addition, shearing stresses are handled better if the thickness of glue is sufficient. Risk of interference between the surfaces is also reduced.

B. Do not wipe the surface or apply product with a rag or paper that leaves lint on the surface.

Lint sticks to rough surfaces and creates undesirable interference between the product and the surface.

C. Do not touch clean, prepared surfaces with bare hands.

The skin contains natural oils that easily transfer to the surface to be glued. This undesirable film stops the glue from adhering to the substrate.

D. Never apply products on a cool structure where there is condensation.

In winter, it is important to make repairs in a heated location. Allow the structure to reach room temperature. If the temperature of the framework is too low, condensation is created on the surface. The effects of various products are completely cancelled if they are applied on a damp surface.
E. **Never remove excess glue from the structure with a sharp object** (retractable-blade knife, putty knife, Exacto, etc.) See Figure 5.

   The knife blades may scrape the assembly’s Sico coating, creating an area susceptible to corrosion. Soft tools with rounded ends are recommended.

F. **Never shape a joint with a finger moistened with pure soap or any other non-recommended product.** See Figure 6.

   Application of pure soap on glues and sealants is undesirable, as it can change the product’s final properties. A diluted soap solution (1 part soap to 10 parts water) can be used to smooth a joint. As contact of glues and sealants with the skin is not recommended, gloves should be worn for this task.

G. **Do not use oil-based solvents to remove excess product or to clean tools.**

   When spread on a joint, oil creates a physical barrier against humid air, which hinders curing.

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**BONDING AND SEALING METHODS**

**BONDING**

Adhesives play an essential role in the assembly and general resistance of the vehicle. For example, the retention of several vertical parts, such as the lateral fiberglass panels, depends only on the quality of the bond.

**VARIOUS TYPES OF GLUE JOINTS**

The bus includes various types of glued joints. Generally, the thickness of glue between two panels should be at least 0.1 in (2.5 mm) to ensure adequate bonding of the panels. In many cases, 3M tape is used as a spacer between the panels to be bonded.

**Flat Joint**

This type of joint is obtained when a panel is glued flat on another surface with 3M tape, which is used as a spacer. With small panels, the glue covers the entire surface. See Figure 7. For large panels, however, the glue is only applied on the perimeter of the panel. See Figure 8.

**Overlap Joint**

This type of joint consists of overlapping panels between which a coat of glue has been applied. For example, Figure 9 shows the joint between the half-roof, the lateral fiberglass panels, and the framework. Several configurations of overlap joint are illustrated in the various bonding diagrams.
End-to-End Joint

This type of joint is made where two fiberglass panels are placed end to end and glued. The glue ensures that the structure holds and that the joint between the two panels is sealed. In certain cases, a sealant must be used instead of glue. See Figure 10.

BONDING ANTIFRICTION STRIPS

See Figure 11.

The antifriction strips (rub rails) are broad, black bands glued to the gelcoat side of the lateral fiberglass panels, close to the thermoplastic skirts. See Figure 1. These strips require a particular bonding technique.

☞ CAUTION:
Before starting the procedure, make sure the corporative adhesive bands are well masked to avoid any contact with the cleaning products.

1. Roughen the surface by sanding it with a Scotch-Brite pad # 7447B (or an equivalent), applying medium pressure in a back-and-forth motion, until a matt finish is obtained.
2. Dust the surface with a clean, dry, white cloth, such as Wypall X60.
3. Clean the bonding area using a degreaser/cleaning product, such as Sika 205, or equivalent.
4. a. For short pieces of antifriction strip, (less than 12 in (30 cm), remove the protective film from the adhesive tape for the complete length of the strip. Stick the antifriction strip on the gelcoat surface.
   b. For long pieces of antifriction strip, remove the protective film from the adhesive tape over a length of approximately 12 in (30 cm). Stick the antifriction strip on the gelcoat surface. Repeat this operation for the complete length of the strip.
5. Once the antifriction strip is affixed, apply medium pressure with a pressure applicator roll.
6. Finish the ends of the strips with a joint of Sika 255FC to avoid any possible surface separation.
BONDING RUBBER COMPONENTS

Rubber components include items such as the rubber seals surrounding the door panels glued to the fiberglass panels.

**NOTE:**
Rubber components generally have a release agent on the surface (to facilitate removal from its mold during manufacture). This must be cleaned off prior to installing such products.

1. Clean rubber with a Chix cloth and ZEP 50 soap (or an equivalent), wiping immediately with a clean, dry, white cloth, such as Wypall X60. **DO NOT ALLOW THE ZEP 50 TO DRY ON THE PRODUCT SURFACE.**
2. Roughen the surface by sanding it with a Scotch-Brite pad # 7447B (or an equivalent), applying medium pressure in a back-and-forth motion, until a matt finish is obtained.
3. Clean rubber with a Chix cloth and ZEP 50 soap (or an equivalent), wiping immediately with a clean, dry, white cloth, such as Wypall X60. **DO NOT ALLOW THE ZEP 50 TO DRY ON THE PRODUCT SURFACE.**
4. Apply Sika Aktivator on the areas to be bonded with a moistened beige Chix cloth, wiping immediately with another clean, dry, beige Chix cloth. Let the Sika Aktivator dry for 10 minutes before applying the adhesive.
5. Apply a bead, 3/8" to 1/2" (10 to 13 mm) thick, of Sika TACK-ASAP (open-time 5 to 8 minutes).
6. Bind the components with **EVEN PRESSURE.**
7. Following assembly, remove any excess adhesive with a wooden or plastic spatula.

BONDING POLYCARBONATE/ABS COMPONENTS

Polycarbonate/ABS components include items, such as the thermoplastic grey skirt panels at the front, street-side and curb-side of the vehicle.

1. Roughen the surface by sanding it with a Scotch-Brite pad # 7447B (or an equivalent), applying medium pressure in a back-and-forth motion, until a matt finish is obtained.
2. Dust the surface with a clean, dry, white cloth, such as Wypall X60.
3. Clean the bonding area using a degreaser/cleaning product, such as Sika 205 or an equivalent (drying time 10 minutes).
4. Apply a thin, even coat ofSika 215 (drying time 30 minutes).
5. Apply a bead, 3/8" to 1/2" (10 to 13 mm) thick, of Sika 252 (open-time 40 minutes).
6. Bind the components with **EVEN PRESSURE.**
7. Following assembly, remove any excess adhesive with a wooden or plastic spatula.

**SEALING**

Sealing is used on the lateral fiberglass panels. Although sealing is used less frequent than bonding, it is as important. Sealing creates a barrier that is impermeable to gas, liquid or solid particles. The quality of the sealing is essential to the integrity and airtightness of the passenger compartment. In certain applications, a sealant can also replace glue.

**VARIOUS TYPES OF SEAL JOINTS**

Joints are made with three sealants (Sika 201, 221 and 552 Aero grey), and sometimes with glue (Sika TACK-ASAP). Joints should be:

- Continuous and without interruption to avoid forming air pockets that could lead to rupture of the joint from use.
- Flat or concave surfaces, depending on circumstances, avoiding accumulation of liquids and dirt.
- Capable of resisting wear and bad weather.
- Attractive and without excessive overflow, particularly on visible parts.

The finishing of joints is usually performed with a gloved finger. The shape of the joint must be concave to ensure run-off of liquids. See Figure 12.

A convex joint creates areas where detachment can happen more easily, and irregular surfaces may trap water or dirt. In smoothing a joint, checks must be made for any interruptions or holes in the joint. Immediately repair any imperfections.

Join continuity is ensured by pushing the cartridge with sufficient flow to create a ball of sealant in front of the spout. This ball prevents the formation of air pockets. If the cartridge is pulled instead of pushed, there is a greater risk of creating air pockets, as shown in Figure 13.
ADDITIONAL INFORMATION ON BONDING AND SEALING

CHEMICAL SURFACE PREPARATION

A properly cleaned surface may still need chemical preparation to improve adhesion. The cleaner SIKA 205 and AKTIVATOR act chemically on the surface to prepare it to react with the glue or the sealant. In certain locations, a primer must be added to improve adhesion of the surface to be glued.

SURFACE CLEANLINESS

Adhesion depends largely on cleanliness of the surfaces before bonding or sealing, because of the very thin layer of glue (1/1,000,000 m) that adheres to the surface of the substrate. A thick film between the panel and the sealant (or glue) would prevent the creation of this adhesive bond. A clean surface is one that is free of solid particles and all liquids.

CLAMPING TIME AFTER CONTACT

The quality of the bond also has an esthetic dimension, so it is important to ensure an adequate, uniform gap between surfaces once they are in contact. The time the panels are held pressed against each other can be important in some cases. Applying a panel on top of the glue, where the panel squeezes the glue due to gravity, does not pose a problem. In contrast, the adhesion of panels installed vertically or on the ceiling will depend on their weight and the strength of the first contact with the glue (green strength).

NATURE OF SUBSTRATES

Substrates are the materials to be bonded or sealed. The quality of bond or sealing depends on these substrates. No other product may be used without an authorization from Nova Bus Engineering.

TEMPERATURE AND HUMIDITY

Generally, as ambient temperature increases, the curing time drops significantly. Thus, for a given relative humidity (ex.: 50%), increasing the temperature by a few degrees can cut the drying time by half.

Relative humidity (R.H.) acts in the same way. Because the curing process requires humidity, the higher the relative humidity, the shorter the curing time. For example, at 73 °F (23 °C), an increase in the relative humidity of several percentage points (ex.: from 40% to 50%) can reduce the curing time considerably. The temperature and humidity parameters mostly affect curing time and tack-free time (or assembly time).

SURFACE ROUGHNESS

When the surface of a material is magnified, its roughness becomes more apparent. The smoother the surface, the less texture it has to catch the glue or sealant.

• The Effect of Roughness on Adhesion
  A rough surface holds the product better and offers more surface to create an adhesive bond. However, a rough surface alone does not necessarily provide good quality adhesion.

• Roughness of the surface and Viscosity of the Product
  Viscosity of the products used, together with the surface roughness, improves the quality of adhesion. The less viscous a product, the easier it can penetrate into rough areas. However, it will also tend to run on vertical panels due to gravity. Conversely, the more viscous a product, the less it will penetrate the surface. This is called the wetting effect. Some substrates, such as glass, have very low roughness and require a high-viscosity product that sticks well from the first contact (green strength) to avoid running. Accordingly, it is important to have a sufficiently rough surface and a product with the proper viscosity for the surface to be glued.

In conclusion, it is necessary to have a sufficiently rough surface and to use a product having the right viscosity for a good quality adhesion.

SIZE AND SHAPE OF THE BEAD

To meet the requirements for mechanical resistance, a glued joint must be of sufficient thickness and area. For example, the space between two glued panels must be at least 0.1 in (2.5 mm), otherwise the glue cannot fulfill its function. The flattened surface of a joint will determine the force the component can withstand before it becomes unglued. The greater the glued surface, the more difficult it will be to remove the glued panel. On the other hand, it should be remembered that the bus will someday have to be repaired, and removal of panels with specialized tools should not be made too difficult.
FINISHING THE JOINT

It is important to finish the joint properly to provide necessary airtight and esthetic qualities. Excess glue or sealant must be properly shaped for two reasons:

• Ensure a continuous, uninterrupted joint in order to avoid areas susceptible to water infiltration;
• Improve the overall appearance and ensure proper contact with surrounding panels to be added.

Excess glue or sealant must be cleaned with the appropriate product and tools. See the PRODUCT AND TOOLS heading of this section.

RUPTURE AREAS AND ASSOCIATED DEFECTS

To check the quality of the bond, glued samples can be subjected to stress tests to determine their resistance and to ensure that the rupture would occur at the right part of the joint. Depending on the result certain conclusions can be drawn.

Ideal Rupture

An ideal rupture indicates that the glue is stronger than the substrate.

The ideal joint is one which, when there is a rupture, leaves part of the substrate on the glue. In this situation, it can be said that the weakest part of the assembly is the substrate, which demonstrates the great strength of the joint.

Rupture in the Glue (Cohesion)

A rupture in the glue indicates that the cohesive strength is weaker. If the product is good and the glue has cured properly, this again demonstrates high-quality gluing (adhesion strength). However, if this situation occurs with low effort, it can be presumed that the glue has not cured. This may be attributable to not respecting the minimum curing time, or to chemical products coming in contact with the joint, thereby altering its chemistry and consequently its resistance to stress.

Rupture Between the Glue and the Substrate

This is the most frequent case, where the glue separates from the substrate, primarily due to poor surface preparation.

Possible causes of this situation may be:

• Poor cleaning (degreasing) of the substrate.
• Handling the substrate surface with bare hands.
• Surface not prepared with SCOTCH-BRITE or sandpaper.
• Dust not removed after sanding.
• Cleaner (SIKA 205 or AKTIVATOR) not used before applying glue.
• Minimum drying time for cleaner not respected.
• Maximum drying time for cleaner exceeded.

Separation Between the Primer and the Substrate

As with the previous case, the causes of this type of separation are the following:

• Poor cleaning (degreasing) of the substrate.
• Handling the substrate surface with bare hands.
• Surface not prepared with SCOTCH-BRITE or sandpaper.
• Dust not removed after sanding.
• Cleaner (SIKA 205 or AKTIVATOR) not used before applying primer.
• Minimum drying time for cleaner not respected.

MAINTENANCE OF THE PANELS

ACCUMULATED DIRT

• Clean the surface with a clean, soft cloth and soapy water to avoid scratches.
• Commercial cleaning waxes, available from boat, pool, or fiberglass bathtub dealers, can also be used on gelcoat surfaces.
• Mild compounds, such as automobile maintenance products, can also be used.
• Do NOT use scouring powders or abrasives. They contain particles that can scratch the gelcoat surface.
• For oil or grease deposits, use solvents such as ethyl acetate or methyl ethyl ketone (MEK).

CAUTION:

Do not confuse methyl ethyl ketone (MEK) with methyl ethyl ketone peroxide (MEKP).

COLOR LOSS SURFACE POWDERING

After prolonged exposure to sun and weather, some gelcoat surfaces may lose their gloss or color, and be covered with a light powdery coating.

1. This condition can be corrected by cleaning the gelcoat surface with a white or red polishing compound, such as the ones sold for automobile maintenance.
2. To be effective, polishing must be performed using a buffing pad mounted on an electric or compressed air rotary polisher. The polisher’s speed must be between 1,500 and 3,000 rpm. This vigorous buffing removes the thin unpolished surface coat and exposes the surface of the gelcoat base.

CAUTION:

To avoid burning the gelcoat coloring, do not apply too much pressure on the polisher, or leave it too long in one place.

3. After preparing the surface, it may be necessary to renew its luster using a wax polish.
**PANEL REPLACEMENT**

Some panels are secured with glue (lateral fiberglass panels) while others are attached with plastic clips (TRIAx panels).

**PARTS FIXED WITH GLUE**

1. To remove the panel to be replaced, use a vibrating knife. The existing bead must be cut as close as possible to the panel.
2. Cut the bead on the structure to a maximum of 0.04 in (1 mm) thick.
3. Clean surface of the cut bead with SIKA 205.
4. Treat the surface of the new part to be glued, according to its composition (fiberglass, gelcoat Triax, etc.)
5. If necessary, add a spacer.
6. Install the new part by applying the adhesive recommended for it. Follow the same gluing pattern that was used to bond the original part.

☞ **CAUTION:**

While installing a fiberglass panel on the structure, it is recommended to apply the adhesive in short vertical lines by leaving intervals of 3 to 4 in (8 to 10 cm) between them. This helps the drainage of any water that could get between the panel and the structure of the bus. See Figure 14.

**PANELS WITH PLASTIC CLIPS**

See Figure 15 for the type of clips found on the TRIAX panels.

1. Place a rubber band at the top border of the panels.
2. Put soap on the rubber band so that it inserts well between the structure and the fiberglass panel.
3. Insert the panel supports in the connectors located on the bus structure.

4. Use a mastic-removing knife cut at 2 in. (5 cm) in length and in width. See Figure 16. Force the panel to bulge slightly. Insert the panel under the fiberglass panel already stuck onto the structure. See Figure 17.
5. When the panel is in position, install the plastic clips to hold the panel in a fixed position.
6. If you have to remove clips, use a screwdriver to unscrew them, or use a claw, as shown in Figure 18. Insert the claw between the panel and the clip and carefully pry the clip out of the hole.

**PANEL REPAIR**

The panels made of composite material can be repaired, esthetically as well as structurally, which enables them to regain their original qualities and aspect.

**SUPERFICIAL REPAIR**

These repairs affect only the gelcoat surface and do not penetrate the laminate structure.

Often, damage incurred in use will be limited to the outer shell of the panel. This includes scratch marks and cracks, due to excessive flexing or an impact limited to the gelcoat thickness.

To carry out an esthetic repair, complete the following procedures:

1. Expose the broken section by sanding the area (about 25 mm around the scratch) with 100-grit paper either by hand or with an orbital sander. See Figure 19.

In case of cracking, the crack must be slightly enlarged into a V to provide adequate grip for the filler compound.

☞ **CAUTION:**

Avoid sanding too deeply to avoid unnecessary damage to the laminate. Limit sanding to the damaged coat or to the depth of the crack.
CAUTION:
If the exposed area is deeper than 0.06 in (1.5 mm) and the laminate structure is damaged, structural repair must also be performed. See the STRUCTURAL REPAIR heading of this section before completing the superficial repair.

2. Clean the exposed area with a dry cloth or small brush to remove all dust.
3. Wash the area with MEK solvent and let it dry completely before proceeding. To avoid contamination, do not touch the surface with your fingers after washing.
4. Use a gelcoat of the same color as the panel. If the area to be filled is deeper than 0.08 in (2 mm), apply a short-fiber putty to improve the structural strength of the repair. An initial coat of reinforced putty is applied before the finish coat. Prepare the quantity of gelcoat needed to fill the exposed area, adding MEKP hardener and mixing thoroughly. The amount of hardener to be used is in the order of 1% to 2% of the weight of the putty.
5. Using a putty knife, fill the exposed area with gelcoat and smooth the surface as much as possible. See Figure 20.
6. Let the gelcoat harden to ensure adequate polymerization. Polymerization will occur at an ambient temperature of at least 70°F (21°C). If the ambient temperature is lower, preheat the area and the broken sections with a spot heater, such as an infrared lamp.
7. After polymerization, the gelcoat may have contracted, leaving a small sunken area on the surface. In that case, repeat steps 3 to 5, applying a thin second coat on the sunken area. Then, repeat steps 4 to 6.
8. Once the surface is filled, sand off excess gelcoat with 320-grit paper (dry), and then finish with a 600 to 1000-grit paper (wet).
9. Paint, if necessary. See the PAINT REPAIRS heading of this section.
10. Using a rotary polisher and a polishing pad, polish the retouched surface with a soft paste. The AQUA-BUFF 2000 paste serves as an example. See Figure 21.

PAINT REPAIRS
If the panel is painted, or if it is impossible to match the color with the gelcoat, the repaired surface can be painted. An acrylic enamel type paint, used in car repairs, can be used. The retouching should cover only the repaired area. To blend in the retouched area, try applying a clear finish coat on top of the colored coat. Spot polishing completes the blending of the painted surfaces.

CAUTION:
Paint repairs must be performed before polishing the repairs.
SUMMARY OF A SUPERFICIAL REPAIR

1. Expose the broken section and sand with a 100-grit abrasive paper.
2. Clean the broken section with a clean linen.
3. Degrease the section with a MEK solvent.
4. Apply a short fiber putty, if necessary.
5. Apply the repairing paste.
6. Let the gelcoat polymerize.
7. If an area has sunk, repeat steps 4 to 6.
8. After hardening, sand the repaired surface with the 320 and 600 to 1000-grit paper.
9. Paint, if necessary.
10. Polish the repaired area with a soft paste or a wax.

STRUCTURAL REPAIR

One feature of composites is that even badly broken sections can have their structural integrity rebuilt. To do this, apply new resin-soaked glass cloth in the necessary number of layers to rebuild the structure.

STRUCTURAL REPAIR DUE TO EXCESSIVE FLEXING OR BREAKAGE OF A SMALL SURFACE

1. Expose the broken section by grinding off all layers of the laminate on the affected part of the panel that are no longer integrally bonded to the panel. See Figure 22.
2. Grinding should leave a beveled edge at least 1 in (25 mm) wide on the edges of the affected area to allow the new laminate to adhere.
2. Cut strips of glass cloth to match the size of the broken area. The strips should cover the whole broken area, and should be layered gradually to improve adhesion to the existing laminate and blend into the edges of the lamination. Measure the number of strips necessary to rebuild the thickness of the laminate.

3. Clean the surface to be laminated with a MEK solvent and allow to dry thoroughly before continuing.

4. Prepare a sufficient quantity of polyester resin by adding the hardener. Add about 1.5% to 2% by weight of hardener, normally an MEKP-type. Prepare only the amount of resin to be used within a 10-minute period. If the broken section requires more time, prepare small batches of resin as needed.

5. Place the strips of fiberglass on a piece of cardboard and soak them in resin using a brush. When the reinforcement is saturated, apply it to the broken surface on the laminate side, and smooth it in place with a roller and a brush. See Figure 23.

Repeat step 5 for each coat of resin required for the repair.

6. Let the composite polymerize at an ambient temperature of at least 70 °F (21 °C) for about an hour. If polymerization is too slow, gentle spot heating with an infrared lamp can be applied. Always avoid overheating the laminate.

7. Once the structural repair has been made to the back of the laminate, it may be necessary, depending on the condition, to add several strips of laminate to the gelcoat side. These strips are required if the depression to be filled is wide enough and is deeper than 0.06 in (1.5 mm). If so, proceed as described in step 7. Avoid overlapping the cloth onto undamaged gelcoat as much as possible. See Figure 24.

8. When polymerization of the gelcoat-side laminate coat is complete, make a superficial repair as previously described in the steps relating to superficial repairs. Sand using a 400-grit paper, finishing with a 800-grit paper.

9. On the back of the laminate, spot-sand any bumps and protruding fibers remaining after lamination.

SUMMARY OF A STRUCTURAL REPAIR DUE TO EXCESSIVE FLEXING OR BREAKAGE OF A SMALL SURFACE

1. Expose the broken section and sand with a 100-grit paper.
2. Cut out the strips of glass reinforcements.
3. Clean the section with a MEK solvent.
4. Prepare the lamination resin.
5. Apply the first layer of laminate. Apply successive layers laminate and remove bubbles.
6. Let the glass/polyester laminate polymerize.
7. If need be, place a few strips of laminate on the gelcoat side.
8. Finish the surface with an esthetic repair.
9. Slightly sand the interior of the laminate to remove any protrusions.

**CAUTION:**

Do not raise the surface temperature above 100 °F (30 °C).
STRUCTURAL REPAIR DUE TO THE BREAKAGE OF A LARGE SURFACE

If there is a large or complex broken section on the panel, it may be necessary to replace an entire portion of the panel. This operation can be performed as follows:

1. Outline the section to be replaced by tracing a simple geometric shape such as a rectangle, circle, or triangle. Cut out the section to be replaced using a saw or grinder. See Figure 25.
2. Remove all dust and clean the lamination areas with a MEK solvent.
3. From the gelcoat side, apply a release film to cover the hole to be filled and to reproduce the surface of the panel. If the surface is large enough or the shape is complex, it may be necessary to support this film with a temporary mold made from a sheet of metal or rigid panel to ensure adequate support for the laminate. This piece can be temporarily glued or screwed into the laminate. See Figure 26.
4. From the laminate side, rebuild the lamination of the structural repair, as described in steps 1 to 6 of the STRUCTURAL REPAIR DUE TO EXCESSIVE FLEXING OR BREAKAGE OF A SMALL SURFACE heading of this section. See Figure 27.
5. After completing the repair and when the resin is well polymerized (about 60 minutes), remove the temporary mold and the release film.
6. Proceed with repairs to the gelcoat side, as described in steps 7 and 8 of the STRUCTURAL REPAIR DUE TO EXCESSIVE FLEXING OR BREAKAGE OF A SMALL SURFACE heading of this section. See Figure 28.
7. Complete the repair with a superficial retouching of the surface on the gelcoat side, as described in steps 1 to 10 of the SUPERFICIAL REPAIR heading of this section.

SUMMARY OF A REPAIR DUE TO THE BREAKAGE OF A LARGE SURFACE

1. Outline and cut out the section to be replaced.
2. Clean the lamination areas with a MEK solvent.
3. On the gelcoat side, apply a release film and a temporary mold.
4. Execute the structural repair on the laminate side.
5. After the resin is well polymerized, remove the temporary mold and the release film.
6. Perform the structural repair on the gelcoat side.
7. Complete with a superficial repair.

PRODUCTS AND TOOLS

HEALTH AND SAFETY RULES RELATED TO PRODUCTS

☞ WARNING:
Before using any product mentioned in this section, also read the health and safety rules found under the COMPOSITE MATERIALS and the PANEL SEALING AND BONDING headings of this section.

A. Prevent any contact between glue, primer or sealant and alcohol or silicone. See Figure 29.

Certain products, such as Sika 205 and Aktivator, contain alcohol. These products react with polyurethanes found in glue, primer and sealant, and alter their physical characteristics. For this reason, a 10-minute waiting time is required after application of cleaners to let them evaporate.
I. When applying Sika 205, do not use an overly saturated rag that drips product. Drops of Sika 205 may fall on other glued joints and alter their structure, especially if they are not completely cured. Sika 205 penetrates Sika 252 glue, and it prevents the curing process and changes the properties of the glue.

RECOMMENDED REPAIR PRODUCTS

- Gelcoat of the required color and thixotropic additive. (CAB-O-SIL or the equivalent). Optional.

**NOTE:**
The gelcoat and thixotropic agent can be replaced by polyester putty, such as body filler with short fibers. In this case, since the color of the product will not match the panel being repaired, it is necessary to spot-paint the repaired surface.

- Body filler (putty) and BPO hardener (short-fiber putty).
- Polyester resin and MEKP hardener.

**CAUTION:**
Do not confuse the solvent (MEK) with the hardener (MEKP).

- Glass reinforcement (intersecting cloth and cloth mat). See the COMPOSITION heading of this section for more details.
- Release agent (cellophane, waxed paper or polyvinyl alcohol film). Optional.
CLEANERS

SIKA 205

CAUTION: Do not confuse the solvent MEK with the hardener (MEKP).

CAUTION: Acetone may be used as a solvent, but is less recommended than those described here, as it evaporates quickly and is highly flammable.

RECOMMENDED BONDING AND SEALING PRODUCTS

DEGREASER

ZEP FORMULA 50

ZEP FORMULA 50 is an all-purpose, biodegradable degreaser that poses no risk to painted surfaces. It can be used in different concentrations (1:1 to 1:5), as required. For Nova Bus use, a concentration of 1:4 is recommended (1 part ZEP FORMULA 50 to 4 parts water). The product is available in a blue 20-liter container.

Cleaning with ZEP FORMULA 50 is recommended on all parts of the bus framework where bonding or sealing is to be done.

SOLVENT, such as ethyl acetate or methyl ethyl ketone (MEK).

Solvent, such as ethyl acetate or methyl ethyl ketone (MEK).

CAUTION: Do not confuse the solvent MEK with the hardener (MEKP).

CAUTION: Acetone may be used as a solvent, but is less recommended than those described here, as it evaporates quickly and is highly flammable.

• Polishing paste (AQUA-BUFF 2000 or equivalent)

RECOMMENDED BONDING AND SEALING PRODUCTS

DEGREASER

ZEP FORMULA 50

ZEP FORMULA 50 is an all-purpose, biodegradable degreaser that poses no risk to painted surfaces. It can be used in different concentrations (1:1 to 1:5), as required. For Nova Bus use, a concentration of 1:4 is recommended (1 part ZEP FORMULA 50 to 4 parts water). The product is available in a blue 20-liter container.

Cleaning with ZEP FORMULA 50 is recommended on all parts of the bus framework where bonding or sealing is to be done.

Drying time .................................................. 10 minutes
Maximum waiting time before next step .......... 2 hours
........... After 2 hours reactivate the surface with Sika 205
Temperature range ..................................... 41° to 95°F
....................................................................... (5°C to 35°C)
Method of application ............................... Thin coat applied
........................................... with a clean, lint-free cloth (CHIX cloth)
Maximum shelf life ................................. 12 months

• Polishing paste (AQUA-BUFF 2000 or equivalent)

CAUTION: Do not confuse the solvent MEK with the hardener (MEKP).

CAUTION: Acetone may be used as a solvent, but is less recommended than those described here, as it evaporates quickly and is highly flammable.

• Polishing paste (AQUA-BUFF 2000 or equivalent)

RECOMMENDED BONDING AND SEALING PRODUCTS

DEGREASER

ZEP FORMULA 50

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Cleaning with ZEP FORMULA 50 is recommended on all parts of the bus framework where bonding or sealing is to be done.

Drying time .................................................. 10 minutes
Maximum waiting time before next step .......... 2 hours
........... After 2 hours reactivate the surface with Sika 205
Temperature range ..................................... 41° to 95°F
....................................................................... (5°C to 35°C)
Method of application ............................... Thin coat applied
........................................... with a clean, lint-free cloth (CHIX cloth)
Maximum shelf life ................................. 12 months

• Polishing paste (AQUA-BUFF 2000 or equivalent)
SIKA 206 G + P

This fast-drying primer is used to improve adhesion of SIKA glues with the following materials:

- Stainless Steel
- XENOY or PVC
- Fiberglass
- Gelcoat
- Painted Steel or Aluminum
- Ceramic Strips on the windows

Drying time at 73°F (23°C) and 50% R.H.... 20 minutes
Temperature range ............................................. 41°F to 95°F
........................................................................... 5°C to 35°C

Maximum waiting time before next step. 2 and 12 hours

If the surface is dusty, clean using a clean, dry, beige cloth
SIKA AKTIVATOR, and wipe immediately with another clean, dry, beige CHIX cloth. If more than 12 hours, apply Sika Aktivator wipe immediately with a clean, dry, beige CHIX cloth.

Method of application ........................ Applicator, brush
........................................................................... or clean CHIX cloth as required.

Maximum shelf life ................................. 9 months

SIKA 215

This fast-drying primer is used to improve adhesion of SIKA glues with the following materials:

- Stainless Steel
- Rubber
- Polycarbonate / ABS
- Fiberglass

Drying time ................................................. 30 minutes
Temperature range ................... 41°F to 95°F (5°C to 35°C)
Method of application .................... Applicator, brush
........................................................................... or clean CHIX cloth, as required.

GLUES

⚠️ CAUTION:
Wear blue nitrile gloves for skin protection.

⚠️ CAUTION:
Only apply on surfaces that are dry, clean, and free of grease and release agents.
SIKAFLEX 252

This glue has a polyurethane base and cures with humidity, which means that chemically, it needs water vapor to cure.

Tack-Free Time*
73°F (23°C) and 50 % R.H. ....................................... 40 minutes
at 35 °C and 90% ............................................... 12 to 15 minutes
Curing rate at 73 °F (23 °C) and 50 % R.H ...0.16 in/24 h
Temperature range for application .......... 41 °F to 95 °F
........................................................................ (5°C to 35°C)
Temperature range for service ...............-40°F to 194°F
........................................................................ (-40 °C to 90 °C)
.................................................................................................. temporarily at 248 °F (120 °C)

*If the assembly time exceeds 12 to 40 minutes (depending on weather conditions), lay a new, smaller bead of Sika 252 glue over the existing bead.

When using SikaFlex 252, it is important to leave the positioning jig in place for at least four hours to ensure that parts are sufficiently bonded.

SIKAFLEX 255FC

This glue has a polyurethane base and cures rapidly. It is primarily used for window applications.

Tack-Free Time*
73°F (23°C) and 50 % R.H. ....................................... 20 minutes
at 35 °C and 90% ............................................... 8 to 10 minutes
Curing rate at 73 °F (23 °C) and 50 % R.H ...0.16 in/24 h
Temperature range for application .......... 41 °F to 95 °F
........................................................................ (5°C to 35°C)
Temperature range for service ...............-40°F to 194°F
........................................................................ (-40 °C to 90 °C)
.................................................................................................. temporarily at 248 °F (120 °C)

*If the assembly time exceeds 8 to 15 minutes (depending on weather conditions), lay a new, smaller bead of Sika 255FC over the existing bead.

When using SikaFlex 255FC, it is important to leave the positioning jig in place for at least four hours to ensure that parts are sufficiently bonded.

SIKATACK-PLUS BOOSTER AND SIKATACK-ASAP

These glues may be used when parts need to be installed rapidly. However, fiberglass and painted parts must be primed with Sika 206 G+P before applying the glue.

NOTE:
Refer to the manufacturer for documentation on these products.

SEALANTS

SIKAFLEX 201

This product is a polyurethane-based elastomer sealant that also cures with humidity. It adheres extremely well.

Tack-Free Time*
at 73°F and 50 % R.H. ........................................2 to 4 hours
Curing rate
at 73°F and 50 % R.H. ........................................0.16 in/24 h
Temperature range for application ..........41 °F to 95 °F
........................................................................ (5°C to 35°C)
Temperature range for service ...............-40°F to 194°F
........................................................................ (-40 °C to 90 °C)
temporarily at 248 °F (120 °C)
Maximum shelf life ........................................ 12 months

SIKAFLEX 221 SEALANT/ADHESIVE

This product is a polyurethane-based sealant that cures with humidity and does not shrink. It is used to seal glued joints, as it is perfectly compatible with Sika 252 glue. In addition, it is very flexible, making it an excellent sealant for moving joints (thermal dilation). It is used on lateral fiberglass panels.

Tack-Free Time*
at 73°F and 50 % R.H. ........................................1 hour
Curing rate
at 73°F and 50 % R.H. ........................................0.16 in/24 h
Temperature range for application ..........41 °F to 95 °F
........................................................................ (5°C to 35°C)
Temperature range for service ...............-40°F to 194°F
........................................................................ (-40 °C to 90 °C)
temporarily at 248 °F (120 °C)
Maximum shelf life ........................................ 9 months

RECOMMENDED REPAIR TOOLS

• Grinder with abrasive tools
• Orbital sander
• Jig saw with metal blade
• Rotary polisher
• Wet-and-dry glasspaper grit n° 100, 320, and 600
• File and sanding disk
• Putty knife
• Polyethylene containers for mixing
• Gloves and safety glasses
• Claw
There are several tools used for applying Sika products. First, there are two types of applicator guns:

- **Compressed-air gun** for applying large quantities with a constant, adjustable flow.
- **Manual gun with trigger** for hard-to-reach spots.

For each of the two guns, there are two types of nozzle, as shown in Figure 32.

- **The glue nozzle.** In most cases, the stem on the glue nozzle can be discarded. It is used only in the application of SIKA 252.
- **The sealant nozzle.** It can be cut at an angle to make it easier to keep the nozzle opening flat against the surface, while applying sealant with the gun held at an angle. It is used for applying SIKA 201 and 221. Tools covered with uncured SIKA products can be cleaned with a rag soaked in acetone; the cured product can be removed with a dry cloth or a tool. To avoid the nozzle being blocked by the cured product, always leave a quantity protruding from the end of the nozzle. It is easy to remove the excess by hand to clear the nozzle.

When making a glue joint (SIKA 252), the product must only be applied to one surface. The sealed or glued joints can be smoothed with a rounded wooden stick or with a scrap of polyethylene.
WARNING:
All health and safety warnings, indicated at the beginning of the main section of this document, equally apply to work carried out using the following materials and procedures identified in this annex.

GENERAL DESCRIPTION

This annex covers the special requirements for the repair and repainting of the silver/grey molded glass/polyester panels used on certain vehicles, in place of the basic white panels.

Certain products used, as well as the procedures involved, differ from the repair and finishing of the basic white panels found in the main section of this document.

This annex contains two procedures. The first procedure covers the repair of the body panels; the second procedure covers the repainting of the panels.

REPAIRING THE BODY PANELS

MATERIALS

List of materials required:
- Cleaner (mix of 60% DuPont 3661 and 40% isopropyl alcohol)
- Base Colour Standox CHA-NO-16
- Universal thinner Standox (Reducer 11905)
- Standox Clear HS, 14580
- Hardener 15-25, 15013
- 2K Fast dry additive 16169
- 2K Fade-out thinner 11031, 11247.

NOTE:
The most ideal climatic conditions for this type of application are a temperature of 68°F (20°C) with a relative humidity of 50%.

1. The area to be repaired must be washed and degreased with the mixed cleaner (60% DuPont 3661 and 40% isopropyl alcohol). Pour some cleaner onto a clean, dry cloth and apply to the area in question. Before the cleaner has time to evaporate, wipe the area with a clean, dry cloth.
2. Remove the polish from an area larger than the zone to be repaired with a 3M HOOKIT II 1500 abrasive or an equivalent, and water. Soak the abrasive approximately 20 minutes before use.
3. Rewash and degrease the area to be repaired with the mixed cleaner. Pour some cleaner onto a clean cloth and apply to the area to be repaired. Before the cleaner has time to evaporate, wipe the area with a clean, dry cloth.
4. BEFORE applying the basecoat Standox CHA-NO-16, mix:
   a. two parts of base CHA-NO-16 with
   b. one part of Standox reducer 11905
5. Apply the basecoat Standox CHA-NO-16 mixture inside the sanded zone until it is completely hidden and until the colour is matched and blended. This may take several coats.

NOTE:
The unpolished surface around the repaired area can easily be polished following the repair to obtain a gloss finish.

NOTE:
Allow to dry completely between each coat. The actual drying time will vary, depending on temperature and relative humidity, but should be approximately 15 – 20 minutes.
6. Use a **tack cloth** between each coat to remove any dust.

7. Perform a visual inspection to ensure that the opacity, colour match and blend are perfect.

8. **Before** applying the Clearcoat (Standox HS 14580), mix:
   a. two parts of the Standox clear with
   b. one part of hardener 15-25
   c. add 5% of Reducer 11905.
   d. to accelerate the process, you may also add 5% of 2K Fast dry additive 16169.

9. Apply two to three coats (1.5-2.5 mils each) of the Clearcoat mixture to cover an area approximately six inches larger than the basecoat applied earlier, but stay within the unpolished zone.

10. Between each coat of clear, it is important to increase the application zone, so as to have only the last coat that blends with the original finish.

11. Following the application of the last coat of clear mixture, mix:
   a. three parts of 2K Fade-out thinner 11031 with
   b. one part of the remaining clear coat mixture from the previous step

12. Once diluted, immediately apply two to three **thin** coats on the overlapping area until it blends with the original surface.

**CAUTION:**

Do not drown the surface with 2K Fade-out thinner, apply **thin** coats and stay within the de-polished zone.

13. Allow sufficient drying time, and then polish lightly. Use an abrasive paste having a fine grit.

**CAUTION:**

Do not overheat the surface being polished.

### REPAINTING THE BODY PANELS

Recipe for the paint mix:

**COLOUR: METALLIC GRAY ELITE BASE COAT CLEAR**

- 8200 E .................................................. 81.9
- PT 198 .................................................. 2.6
- 200 .................................................. 193.6
- 168 .................................................. 3
- 102 .................................................. 1.7
- 105 .................................................. 5
- 114 .................................................. 128.6
- 190 .................................................. 13.3
- 125 .................................................. 1.5
- 122 .................................................. 2.5
- 8285 .................................................. 108.2

1. Mask the area that is not being painted
2. Sand with abrasive paper 800 grit
3. Clean off dust with compressed air
4. Apply a small quantity of BASF prepaint RM901 cleaner to a clean, dry cloth and wipe the area clean
5. Wipe the area with a **tack cloth** to remove any dust residue
6. Apply the paint:
   a. Mix the paint as follows:
      a. 3 parts of paint
      b. 1 part of catalyst (DuPont high solid urethane 194S Activator)
      c. 2 container-caps full per gallon of paint of DuPont 389 Fast Dry accelerator
7. After painting, wait 30 minutes.
8. Apply the Clearcoat
   a. Mix the Clearcoat as follows:
      a. 3 parts of Clear (DuPont Imron® Low HAPS clear 3480S)
      b. 1 part of catalyst (DuPont high solid urethane 194S Activator)
      c. 2 container-caps full per gallon of paint of DuPont 389 Fast Dry accelerator
RETOUCHING DAMAGED AREAS (BLENDING)

1. Mask the area not being painted
2. Sand with abrasive paper 500 grit
3. Clean off dust with compressed air
4. Apply a small quantity of BASF prepaint RM901 cleaner to a clean dry cloth and wipe the area clean
5. Wipe the area with a **tack cloth** to remove any dust residue
6. Paint with a mixture of Clearcoat and Blender
   - Mix as follows:
     a. 8 parts of Blender
        (DuPont Blending Clearcoat 3401S)
     b. 1 part of catalyzed Clearcoat
   - Mix the catalyzed Clearcoat as follows:
     a. 3 parts of Clearcoat
        (DuPont Imron® Low HAPS Clearcoat 3480S)
     b. 1 part of catalyst
        (DuPont high solid urethane 194S Activator)
     c. 2 container-caps full per gallon of paint of DuPont 389 Fast Dry accelerator
7. Wait for 5 minutes
8. Apply the paint
   - Mix the paint as follows:
     a. 3 parts of paint
     b. 1 part of catalyst
        (DuPont high solid urethane 194S Activator)
     c. 2 container-caps full per gallon of paint of DuPont 389 Fast Dry accelerator
9. Wait for 10 minutes
10. Apply the Clearcoat
    - Mix the Clearcoat as follows:
      a. 3 parts of Clearcoat
         (DuPont Imron® Low HAPS Clearcoat 3480S)
      b. 1 part of catalyst
         (DuPont high solid urethane 194S Activator)
      c. 2 container-caps full per gallon of paint of DuPont 389 Fast Dry accelerator