Automotive
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SMC PAINT MANUAL ADDENDUM FOR EXTERIOR BODY PANELS

An addendum for the
SMC Paint Manual for
Exterior Body Panels
published by the
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SMC Paint Manual addendum
Exterior Body Panels

- Introduction

This is an addendum for the SMC Paint Manual for Exterior Body Panels published by the Automotive Composites Association (ACA), formerly the SMC Automotive Alliance. This addendum is designed to compliment the ACA paint manual by providing focus on reduction of paint defects at the OEM such as paint pops. Also included in this addendum are composite best practices for handling, rack design, transportation, tool design, and surface appearance.

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PRIMER AND SUBSTRATE ANALYSIS TO REDUCE PAINT POPS ON SMC

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ABSTRACT

The experiments discussed in this paper provide a specific strategy for increasing the robustness of SMC automotive body panels by reducing paint pops in subsequent coating processes such as top coating. It was significantly concluded that paint pops, as a result of substrate defects and damage occurring before the priming process, could be reduced by optimizing three factors: type of primer applied, toughness of the SMC, and the bake profile used to cure the SMC primer system. It was also concluded that the toughness of the SMC had an extreme impact on reducing paint pops that resulted from damage after the priming process at the tier one facility. The experiments were conducted on test panels that were intentionally damaged using a controlled procedure to simulate the paint pop defect.

Introduction

In order to keep SMC prosperous in the automotive market, it must provide its advantages while processing like steel. One of the most predominant defects that SMC must overcome occurs in the final paint application at assembly. The defect termed as "paint pop" or sometime generalized as "porosity" is a crown or small blister ranging from 0.10 to 0.25 inches in diameter in topcoat finish.

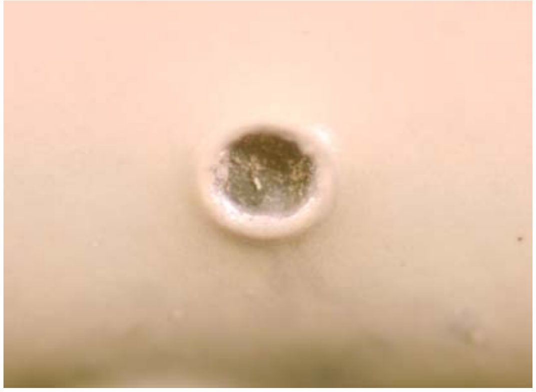

Figure 1 – Paint pop in base coat

In general, a paint pop is produced by pressure exerted by a gas formed beneath the applied coating during the bake cycle. The gas can be a result of cracks, gouges, pits, porosity, exposed glass fibers, sanded substrate and defects in the primer applied to the substrate. The gas itself can have a number of compositions, such as vaporized solvent from the applied coating system, water vapor and air from enclosed voids. Other defects, such as solvent boil in the applied finished coating layer, are often included in the category of paint pops, but are not caused by defects of the supplied SMC panels. This defect can only be corrected through process optimization of the assembly plant's paint process and may bias plastic panels based on the thermodynamic properties of SMC as compared to steel.

To design a strategy to reduce pops, causes must be understood and quantified. A microscopic analysis of defects was performed on several different body panels supplied to 10 different assembly pants. Table 1 summarizes the results of over 300 cataloged analyses that were identified by the final assembler as paint pops.

Table 1 – Root Cause of Pop by Microscopic Analysis

Defect Root Cause	*Percent**
Substrate (voids, non-fill or contamination)	6-17%
Damage before primer application at tier 1 molding plant	5-15%
Defect contained to the primer layer and/or process at tier 1 molding plant	3-15%
Damage after primer application at tier 1 molding plant (i.e. handling damage at tier 1, shipment and/or final assembly)	20-30%
Defect maintained in applied primer surfacer layer and/or process applied at assembly (i.e. solvent boil, contamination or blistering)	5-30%
Defect maintained in applied base coat/clear coat layer and/or process applied at assembly (i.e. solvent boil, contamination or blistering)	5-25%

- Ranges are used to denote that there are differences in percentage ratios for particular designs, processes and applications of SMC panels that are not detailed in this paper.

Table 1 demonstrates that a significant portion of paint pops can be addressed with an optimal paint process at the tier 1 molding plant that would seal the substrate. However a larger percentage of defects are beyond the realm of the coating application at the molding facility and must be addressed with substrate improvements or process improvements at the assembly plant. This paper concentrates on optimizing the tier 1 molding plant primer application and improvements to the SMC substrate.

To optimize primer application at the tier 1 molding plant, two approaches predominate. One approach uses a coating system that has a low activation temperature. In particular, applying 2K isocyanate systems that cure at temperatures as low as room temperature compared to 1K melamine systems that can have a minimum cure of 260ºF (127°C). The hypothesis here is the 2Kisocyanate paint will begin curing and build film integrity before the substrate is greatly heated and produces gases. This allows the 2K isocyanate to seal the substrate by preventing gases from causing imperfections such as fissures or pops in the primer film. The second approach would be to introduce a lower or stepped ramp to the oven profile. This is believed to allow gasses to escape through the applied primer film at slower rates instead of a concentrated burst. The experiments in this paper will take in account molding facilities that spray several types of coating systems and must maintain temperature to cure 1K primer and/or topcoat systems.

To design an improved class “A” automotive grade SMC that offers an excellent surface appearance substrate with pop resistance was challenging because several approaches had to be examined for effectiveness. The general idea was to produce a substrate that would be resistant to crazing and/or cracking during all processing conditions, such as when removing the part from the mold, adhesive bonding, finish handling and shipping. This was accomplished through longevity then resin matrix of the substrate.

To produce significant increases in the strain energy per unit volume of 80 to 120%, altering the chemistry of the unsaturated polyester resin component listed in Table 2 is necessary. The unsaturated polyester resin was developed by incorporating process and monomer changes in a series of lab resin cooks with the collaboration of AOC. The new resin chemistries were then incorporated into an SMC formulation referred to as “Tough Class A SMC” (TCA). The TCA was evaluated for pop resistance with other class “A” SMCs in tests similar to the General Motors Engineering Standard 9984803 to find it was effective at reducing pops.

Experimental Method for Pop Evaluation

SMC Panel Preparation. The test specimens were SMC strips sawed from 10" x 18" plaques, compression molded to production practices. The specimens are 2" wide by 18" long and have a thickness of 0.1". One-half inch of edge material is first cut off the plaque and discarded. The 2" x 18" SMC strips are sequentially cut. The strips are marked on the back of the panel with the material type and A, B, C, etc., to allow plaque positions to be defined. A center specimen with an air popper mark is discarded. Edges are beveled with a file, sandpaper or disc sander. Specimens are cleaned of dirt to a reasonable extent using compressed air and a dry cloth.

Flex Procedure for Stressing SMC Test Panels. The flex procedure is applied to raw SMC panels without primer or to SMC panels after they have been primed. The condition of stressing before prime is termed pre-stressed, and the condition of stressing the panels after they have received the prime is specified as post-stressed. In any case, the panel is stressed only one time.

The flex procedure is performed on an 8.25" cylindrical mandrel. The 8.25" radius is designated to assure visible cracking to all SMC materials being evaluated. The SMC strip is placed so that the back of the panel is in contact with the mandrel. Starting by holding one end of the strip to the mandrel in a tangent position, the other end is pulled to the center of the mandrel until the panel conforms to the circumference and is then held for five seconds. The panel then is released, allowing the specimen to return to a relaxed state, which is usually slightly curved.

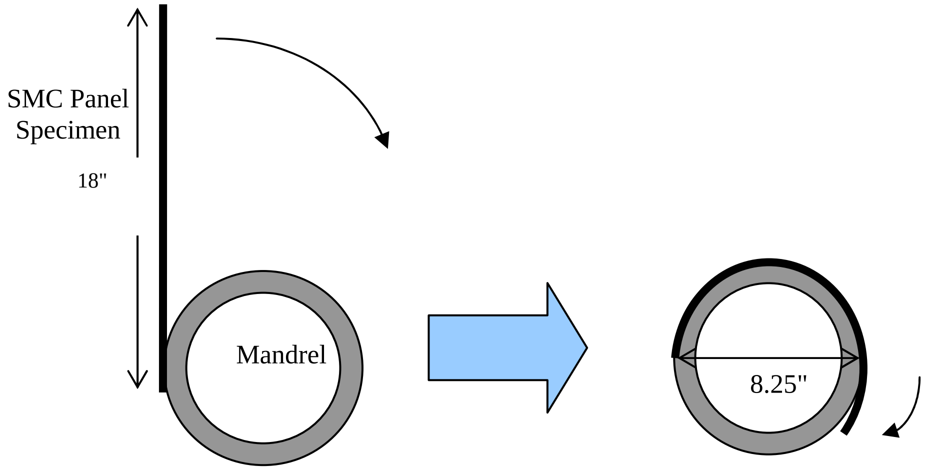

Figure 3 – Procedure for Flexing Panel Specimens

1K and 2K Primer Methodology and Primer Bake Process. One of the goals of this experiment was to study how 1K-melamine systems and 2K-isocyanate systems influence pop reduction. To obtain a general consensus, several gray and black primers systems were evaluated that were accepted by the automotive industry as SMC primers. A total of four 1K systems and four 2K systems were obtained by three suppliers, each submitting an equal number of 1K and 2K systems. These systems will be noted in this experiment as 1K primer 1, 1K primer 2, 1K primer 3,1K primer 4, 2K primer 1, 2K primer 2, 2K primer 3 and 2K primer 4.

The primer systems were applied to panels that were flexed (pre-stressed) and panels to be flexed (post-stressed). The panels were given a final wipe with isopropyl alcohol and then primer was applied with lab application to obtain a 1mil dry film thickness. The panels were then flashed for 10 minutes at room temperature and then placed in a lab oven to receive one of two bake profiles illustrated in Figure 4. Manual oven procedures were developed using temperature verses time data collection to obtain the approximate profile of Bake 1 and Bake 2.

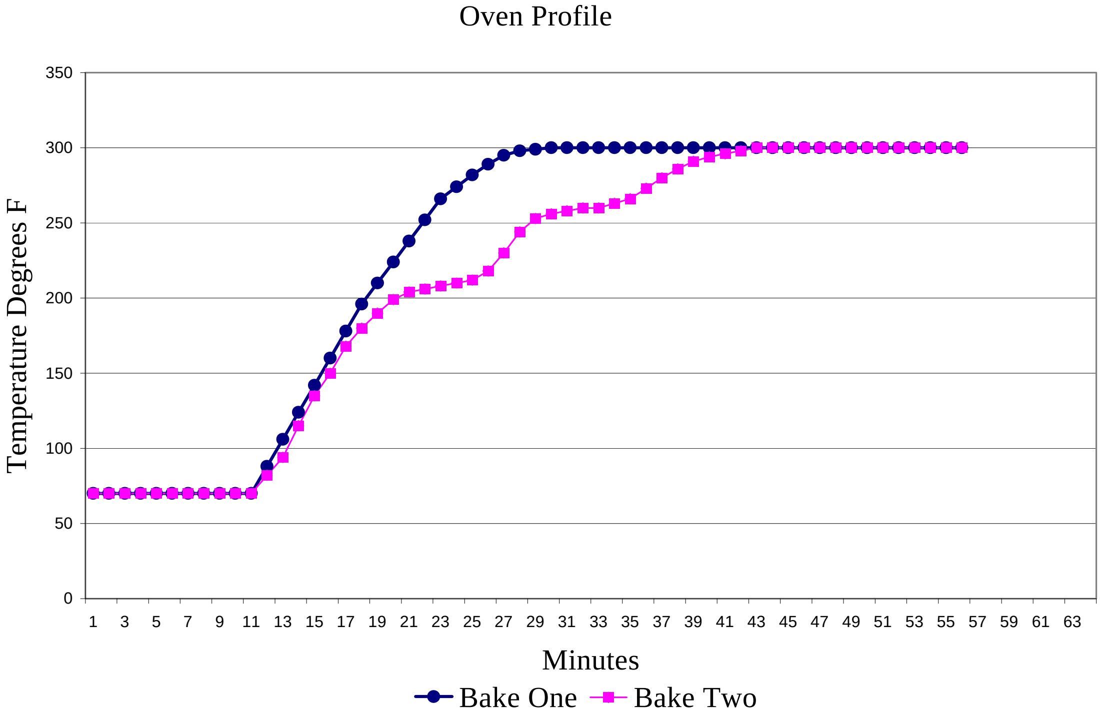

Figure 4 – Oven Profiles of Bake 1 and Bake 2

Application of Assembly Coating and Evaluation of Pops. All panels were sent to a research and development center of a major automotive topcoat supplier. The panels were all simultaneously exposed to an electro-coat bake simulation that maintained 380º F (193°C) for 30 minutes and then allowed to stand for 16 hours at ambient conditions. They then were topcoated with a currently-in-use automotive paint system. Application parameters simulated assembly plant conditions.

Three judges examined the topcoated panels and tallied the pop counts. Each judge had considerable experience with and knowledge of paint defects that occurred on plastic components.

Design of Experiment. The experiment was designed to evaluate three factors under the condition of damage before primer application - pre-stressed panels, and under the condition of damage after primer application - post-stressed panels. Factor 1, type of paint system, evaluates 1K melamine and 2K isocyanate systems. Factor 2 evaluates two types of oven profiles -- a fast steady ramp (bake 1) and a ramp with steps (bake 2). See Figure 4. Factor 3 evaluates two types of substrate, a standard class “A” SMC (control) and a class “A” substrate with increased toughness (TCA). The experiment was performed as a full factorial design with one set of replicates for each of the coating systems. Table 3 is the full layout of the experiment and contains all of the reported results.

Table 3 – Experimental Layout and Results

Factors			*Pre-stress*		*Post-stressed*	
Paint System	Oven Profile	SMC Substrate	Pop Count Panel 1	Pop Count Panel 2	Pop Count Panel 1	Pop Count Panel 2
1K primer 1	Bake 1	Control	5	7	193	95
1K primer 1	Bake 1	TCA	0	0	3	10
1K primer 1	Bake 2	Control	1	1	77	55
1K primer 1	Bake 2	TCA	0	0	4	1
1K primer 2	Bake 1	Control	1	1	93	37
1K primer 2	Bake 1	TCA	1	0	3	2
1K primer 2	Bake 2	Control	3	0	56	97
1K primer 2	Bake 2	TCA	0	0	3	2
1K primer 3	Bake 1	Control	9	23	50	27
1K primer 3	Bake 1	TCA	0	0	2	2
1K primer 3	Bake 2	Control	4	6	115	61
1K primer 3	Bake 2	TCA	0	0	19	4
1K primer 4	Bake 1	Control	2	5	164	166
1K primer 4	Bake 1	TCA	4	2	1	0
1K primer 4	Bake 2	Control	0	2	51	106
1K primer 4	Bake 2	TCA	2	0	2	4
2K primer 1	Bake 1	Control	0	1	141	196
2K primer 1	Bake 1	TCA	1	2	5	0
2K primer 1	Bake 2	Control	0	0	46	75
2K primer 1	Bake 2	TCA	0	0	5	4
2K primer 2	Bake 1	Control	0	1	85	122
2K primer 2	Bake 1	TCA	0	0	3	0
2K primer 2	Bake 2	Control	0	0	41	115
2K primer 2	Bake 2	TCA	0	1	7	1
2K primer 3	Bake 1	Control	0	0	146	170
2K primer 3	Bake 1	TCA	0	0	6	20
2K primer 3	Bake 2	Control	0	0	92	177
2K primer 3	Bake 2	TCA	0	0	3	2
2K primer 4	Bake 1	Control	0	1	85	129
2K primer 4	Bake 1	TCA	0	1	2	1
2K primer 4	Bake 2	Control	2	0	72	15
2K primer 4	Bake 2	TCA	0	0	6	7

The data was then transformed into an 8 level design of experiment by averaging the paint systems' results into two categories: 1K melamines and 2K isocyanates. Table 4 provides the average results and the standard deviation of the four primer systems of each category for reference. The results discussed in the next section were derived from the 8 level factorial design analysis as outlined in Table 4. For each level, eight of the appropriate results were entered from Table 3 as replicates.

Table 4 – Level 8 Design of Experiment Layout

Level	Factors			Pre-stressed		Post-stressed	
	Paint System	Oven Profile	SMC Substrate	Average of 4 Primers & Replicate	Standard Deviation	Average of 4 Primers & Replicate	Standard Deviation
1	1K Melamine	Bake 1	Control	6.6	7.2	103.1	64.2
2	1K Melamine	Bake 1	TCA	0.9	1.5	2.9	3.0
3	1K Melamine	Bake 2	Control	2.1	2.1	77.3	25.5
4	1K Melamine	Bake 2	TCA	0.3	0.7	4.9	5.8
5	2K Isocyanate	Bake 1	Control	0.4	0.5	134.3	38.4
6	2K Isocyanate	Bake 1	TCA	0.5	0.8	4.6	6.6
7	2K Isocyanate	Bake 2	Control	0.3	0.7	79.1	50.4
8	2K Isocyanate	Bake 2	TCA	0.1	0.4	4.4	2.3

Discussion of Results

Figure 5 is a plot of the main effect of paint system, oven profile and substrate factors on the pop numbers of pre-stressed test panels.

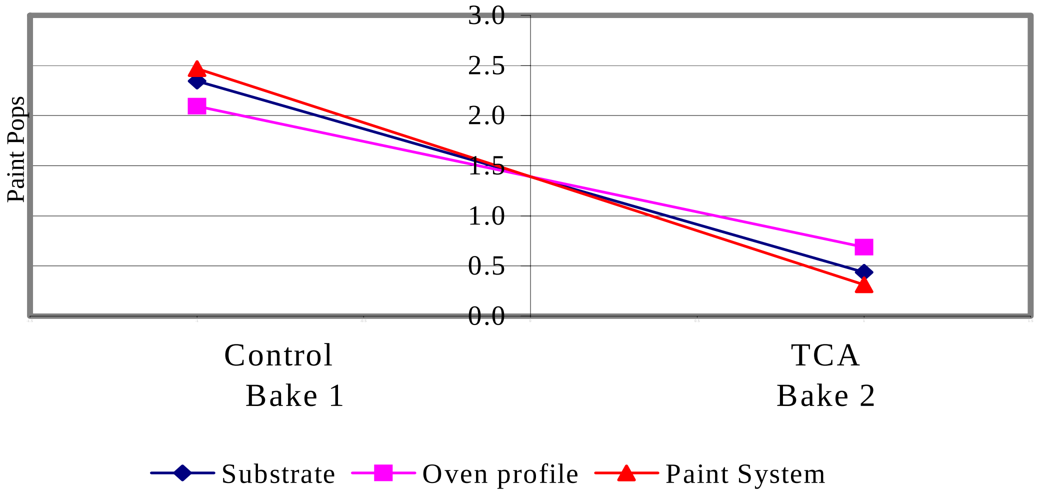

Figure 5 – Main Effect Plot of Pre-stressed Condition

All three factors had a significant influence upon pop suppression at a 95% confidence level. The paint system factor had the greatest influence for pop reduction. The 2K isocyanate system had an 87% reduction in pop count as compared to the 1K melamine system. The substrate type had a lesser but similar impact. The occurrence of pops on TCA was 81% less than the pops that occurred on the control class "A" SMC substrate. The slower stepped ramp oven profile of bake 2 had a 67% reduction in pops as compared to the continuous fast ramp of bake 1. It is understandable that all three factors had a significant effect upon pop reduction because pre-stressing provides an opportunity for the priming process to seal the substrate.

The effect of the 2K factor is hypothesized to be mainly a factor of reaction rates at lower temperatures. The 2K isocyanate has the ability to start curing at room temperature and during introduction to the oven, which is far lower than the initial reaction temperatures of 1K melamine systems, which require a temperature of about 260ºF (127ºC). The lower cure of 2K isocyanates allows for the development of a hard, continuous film before the substrate is heated to a temperature that causes the rapid escape of gases. As a result, pops and fissures in the applied primer layer that can create paths for gas to expel during subsequent coating processes are significantly reduced. However, it can be noted from the standard deviations reported in Table 4 that there are some substantial variances among the 1K and 2K coating systems for each level of the experiment. This is very understandable because there are many factors that control how quickly a coating will build toughness and hardness. A short list of considerations would include catalyst levels, solvent package evaporation rate, percent solids, resin type, molecular weight of resins, potential cross-link density and reactivity of each type of functional group. All of these factors could be topics for future studies for coating optimization for pops.

The effect of substrate was expected based on the hypothesis summarized in the introduction. At this time, it can be suggested that the TCA had a reduction of pops because the cracks were not as severe and TCA has the ability to retract and close cracks due to the increased toughness of the matrix. It was observed during the experiment, however, that the TCA did crack because the cracks were visible as they telegraphed through to the surface of the primer layer, which was consistent with the control substrate.

Bake profile was the least effective of the three factors, however it still had a significant effect on pop reduction. The oven profile of bake 2 was optimized to have small plateaus at about 210ºF (99ºC) and 260ºF (127ºC) instead of having the consistent fast ramp of bake 1. The plateaus in bake 2 are believed to allow time for any trapped gas to slowly permeate through the liquid or semi-hardened primer film and escape without producing pops or fissures in the fully-cured primer layer. This effect was noted in several previous experiments that found that any coating on an exaggerated porous substrate could be cured without pops if the ramp rate is small enough. Though this theory can be proven for a number of systems, most production processes will not tolerate the time for a ramp rate of 1 to 2 degrees per minute.

Figure 6 is a plot of the main effect of paint system, oven profile and substrate factors on the pop numbers of post-stressed test panels.

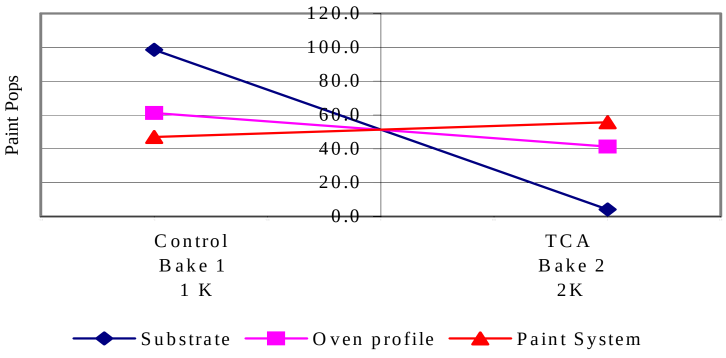

Figure 6 – Main Effect Plot of Post-Stressed Condition

Only two of the three factors had an influence upon pop suppression at a 95% confidence level -- substrate and oven profile. The type of substrate had the greatest influence on pop reduction; the TCA reduced pops by 96% as compared to the control SMC. The oven profile had only a small impact with a 32% reduction in pops. The coating system type was not found to be statistically significant; however, the 1K system indicated a small reduction in pops. The small influence of the painting process was predicted in the post-stress scenario because the primer film itself is being mechanically damaged.

The effect of the TCA substrate to reduce pops was expected, but the magnitude of the effect was astounding. This result is very promising considering the defect analysis of returned parts from the assembler as mentioned in the introduction. This analysis found that the majority of the surveyed paint pop defects were related to damage after the primer was applied at the tier one molding facility. This, unfortunately, diminishing the effect of any strategy to seal SMC with an effective primer process. This was demonstrated in the experiment by comparing the overall average pops per test panel for the pre-stressed condition that was two pops to the post-stressed condition that had an average of 50 pops. With the barrier of the sealer destroyed, the pop count increased by 25x in magnitude. The TCA SMC substrate in the post-stressed condition reduced paint pops from an average of 98 pops per panel to four pops.

The small effect of the bake profile is concluded to be a function of the primer film brittleness. The lower oven profile induces the paint to be less brittle by slightly reducing cross-link density and lessening the bake out of plasticizers. The effect on mechanical behavior can be further quantified using differential mechanical analysis for each coating system cure at controlled conditions. The reduced brittleness of the coating allows it to produce fewer cracks and increases the potential for the cracks to close effectively after the panel is relaxed. In general, not over curing a primer on SMC can be effective for reducing pops caused by preliminary handling and shipping stresses, but the effect will dissipate as the panel is exposed to several required bakes during the assembly process. This reasoning can also explain why the 1K system that requires higher bake temperatures was found to be more effective for the post-stressed condition. However, due to lack of statistical significance in this experiment, it will not be discussed further.

Conclusion

The results of the experiments discussed in this paper provide a specific strategy for increasing robustness of SMC automotive body panels by reducing paint pops in subsequent coating processes. It was significantly concluded that paint pops as a result of substrate damage occurring before the priming process could be reduced by optimizing the following factors listed in order of effectiveness: the use of a 2K isocyanate as compared to a 1K melamine system, the use of a toughened SMC substrate (TCA) as compared to the control class "A" SMC substrate, and the use of a low ramp bake with plateaus as compared to a rapid continuous ramp bake. It was also concluded that TCA had an extreme impact on reducing paint pops on panels that were damaged after the priming process at the tier one facility.

The experiments conducted in this paper were confined to a simplistic design to predict the general effect of the three factors on test panels that simulated the end defect. However, predicting the occurrence of paint pop defects for each coating process requires a complex science. It has been found that paint pops can be caused or intensified by any part of the process, from the compounding of the substrate to the final paint bake at assembly. Experiments are continuously occurring which are expanding the concepts in this paper to several other conditions and topcoat systems for verification and development of new postulations.

References

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2. Chanda, M. and Roy S. K., Plastics Technology Handbook: Second Edition, Marcel Dekker, INC., New York, New York, 257 (1993)

UV

The previous research presented has definitely provided evidence that two component systems that cure at lower temperatures has a advantage for reducing paint pops. Ultra violet (UV) systems also have been found to be successful at decreasing paint pops and function on a similar hypothesis as the two component systems, a lower curing temperature. In general, UV systems can be activated at room temperature to start cross linking and building integrate before the substrate is greatly heated releasing gases that cause imperfections in the final film. A paint system, developed by BASF, and a process adequate to cure large three-dimensional parts, has been commercialized with success of greatly reducing paint pops on supplied automotive panels. The BASF UV also has a built in post thermal cure to assure adequate curing in shadow zones or if UV lamps are not adequately powered. This process is more common in Europe and is being investigated with more intensity in North America by other paint suppliers and UV equipment distributors.

ACA
BEST PRACTICES

RACK DESIGN

1.0 Purpose:

This work instruction will outline the details of designing returnable shipping containers for SMC parts in the automotive environment. Any deviation from this practice requires written core team sign-off.

The specific items addressed in this instruction are:

- Part orientation in shipping container.
- Loading and unloading best practices.
- Suggested dunnage material for unique designs.
- Swing arm mechanics and orientation.

This work instruction will suggest design details to ensure part quality as it relates to Material Handling and transportation of parts.

2.0 Definitions:

Dunnage:

Materials used support parts inside the metal returnable container. The dunnage is usually fastened to the racks and removed only for repair.

Clearance:

The pocket or location in the rack that is first contacted by the part during loading.

Unloading Target:

The area on the part that is gripped by the operator during unloading.

3.0 Input Required:

- Math data of part

- Processing and ergonomic requirements at Manufacturing and Assembly facilities.

4.0 Procedure:

4.1 Loading and unloading
- 4.1.1 Do not slide panels on edge across dunnage.
- 4.1.2 Rest part on non “A” surface.
- 4.1.3 Loading clearance should be at least ½” (12 mm) on either side of panel.
- 4.1.4 Do not allow part-to-part or part to rack contact on “A” surface during transportation or loading.
- 4.1.5 Tilt panels to dunnage targets can be seen while loading.

4.2 Materials
- 4.2.1 Use expanded urethane dunnage 27#, 20-35 or equivalent durometer for dunnage bars.
- 4.2.2 Ethafoam, cross-link foam or any closed cell, non-marking foam can be used to protect parts that rest within 2” of rack structure.
- 4.2.3 Use dunnage bars as opposed to bases for resting large panels on.
- 4.2.4 Use nut and bolt system for swing arms for repairs.
- 4.2.5 Stud covers can be used if clearance is less than 1”. (part specific)

4.3 Part Orientation:
- 4.3.1 Orient part with “A” surface toward operator, walk-in style racks.
- 4.3.2 Reduce “A” surface exposure to horizontal orientation.
- 4.3.3 Secure part is orientation that is least vulnerable to dust accumulation without sacrificing rack or transportation density.

4.4 Rack Design
- 4.4.1 Provide generous lead-in on finger bar dunnage to reduce primer rub off.
- 4.4.2 Restrict panels for movement in fore-aft and vertical direction.
- 4.4.3 Do not allow dunnage to support part on a corner or tip.
- 4.4.4 Secure all cable and chains to rack to prevent I from hitting parts during transit.
- 4.4.5 Ensure dunnage is securely fastened in T-bar with no movement, rotation or slide.
- 4.4.6 Angle dunnage so unrestricted part is held by gravity
- 4.4.7 Strive to orient swing arms so dunnage is down in open position.
- 4.4.8 Ensure swing arm can close without mechanical assistance.
- 4.4.9 Consider using toe plates above fork pockets where applicable.
- 4.4.10 Verify provisions for part identification are on rack.

5.0 Procedure Output:

The following items are generated by the above procedure:

- ➢ Shipping equipment loading and unloading directions.
- ➢ Rack design drawing

6.0 Records Retained:

The following records are retained at the part supplier’s location:

- Shipping equipment loading and unloading directions
- Rack design drawing
- Core team sign-off agreeing to deviation from these practices

7.0 End

RACK MAINTENANCE AND REPAIR

1.0 Purposes

This work instruction will outline the preventive maintenance process of SMC shipping containers.

The specific items addressed in this instruction are:

- When Preventive Maintenance to be completed.
- Requirements to complete the Preventive Maintenance Form.
- Where concerns will be tracked, if required.
- Expectations of SMC customers.

This work instruction will suggest the minimum requirements of preventive maintenance to ensure part quality as it relates to Material Handling.

2.0 Definitions:

Maintenance:

Scheduled inspection of a fleet of shipping containers and the measures taken to bring the container back to its original specifications by cleaning, tightening bolts, greasing components, realigning dunnage etc.

Repair:

Unscheduled rework or replacement of broken end frames, dunnage bars, latch assemblies, rack base etc. needed to bring a damaged shipping container back to its design intent. Dunnage replacement is considered a repair. This rework is funded by the owner of the container fleet on an “as needed” basis and rework is done in house or by an approved vendor when necessary.

3.0 Input Required:

- Shipping Container Preventive Maintenance Log.

- The latest level engineering prints and bill of materials.

4.0 Procedures:

4.1 Prior to loading rack with parts.
  4.1.1 Sweep all dust and debris from base and dunnage of rack.
  4.1.2 Open and close lock-off bar to ensure proper alignment
  4.1.3 Scan rack to see if nuts or bolts are missing from movable parts.
  4.1.4 Check dunnage for damage at part contact area.
  4.1.5 Replace any critical components

(AUDIT PROCESS ONCE PER MONTH VIA PLANT WALK-THROUGH)

4.2 Once per quarter:
  4.2.1 Wash entire rack and dunnage and allow to dry prior to use.
  4.2.2 Using form SMC001, repair as needed:
    4.2.2.1 Check length, width, and height dimensions to print
    4.2.2.2 Inspect all dunnage for design intent and replace as needed
    4.2.2.3 Replace broken latch assemblies
    4.2.2.4 Replace broken end frames
  4.2.3 Tighten all nuts and bolts
  4.2.4 Grease zerch fittings

(AUDIT PROCESS ONCE PER YEAR)

4.3 Fill out rack log sheet with date, part description, maintenance person, and quantity of containers in fleet.

4.4 Record rack number on log and any corrections made to rack.

4.5 After rack has been reviewed, place a PM sticker with date and initials on the rack.

5.0 Procedure Output:

The following items are generated by the above procedure:

- (1) Completed Shipping Container Preventive Maintenance Log.
- (1) Completed Shipping Equipment deviation report as needed.

6.0 Records Retained

The following records are retained in the Maintenance Department:

- (1) Completed Rack Drawing Set
- (1) Completed Shipping Container Preventive Maintenance Log
- (1) Shipping container deviation report for any racks out of service.

7.0 End

ACA
BEST PRACTICES

TRANSPORTATION OF SMC PARTS TO ASSEMBLY PLANTS

1.0 Purpose

This work instruction will outline the details of shipping containers of SMC parts in the Ford automotive environment. Any deviation from this practice requires written core team sign-off.

The specific items addressed in this instruction are:

- Shipping container orientation in truck and rail moves.
- Equipment specifications
- Equipment hook ups and transfers

This work instruction will suggest details to ensure part quality as it relates to Material Handling and Transportation of parts.

2.0 Definitions:

Leaf Spring Suspension:
Coiled suspension used on trucks that creates a natural frequency in the range of 2-18 Hz.

Air Ride Suspension:
Air bladder suspension used on trucks that creates a natural frequency out of the range of 2-18 Hz.

Humping:
Rail car hook-up causing more than 1 G of force on the load inside the rail car.

3.0 Input Required:

- Part description includes an “A” surface
- Logistics of move

4.0 Procedure:

4.1 Packaging Engineering notifies OEM engineering of air-ride requirement
  4.1.1 During concept review, transportation needs are determined
  4.1.2 Packaging Engineer e-mails logistics analyst the requirements
4.2 Logistics Analyst quotes only companies that can provide the proper style of equipment
4.3 Logistics Analyst confirms proper equipment is secured
  4.3.1 Logistics Purchasing notifies Logistic Analyst of company and equipment
  4.3.2 Logistic Analyst emails transportation company and equipment specs to Packaging Engineer
  4.3.3 Packaging Engineer notifies supplier of transportation equipment at container prototype review

5.0 Procedure Output:

The following items are generated by the above procedure:

- E-mails documenting equipment

6.0 Records Retained:

The following records are retained at the part supplier’s location

- Transportation equipment request
- Transportation equipment confirmation
- Core team sign-off agreeing to deviation from these practices

7.0 End

SMC Mold Tool Shear Edge Design

1. Chromed SMC tool shear edge gaps are specified to fall below 0.006” (0.1254 mm) during the design process for all edges of the part. This specification applies to the flash closest to the part, as designed in differences in the shear draft angle between core and cavity will result in thicker flash as measurements proceed away from the part.

2. Draft angles on shear edges are to be between 0” and 1.5” relative to the direction of press closing with the draft angle of the cavity being 0” – 0.5” greater than the draft angle of the core. These draft angle specifications do not apply to injection-molded SMC tooling with shear edges, as these tools are fully closed to stops prior to SMC injection. For compression molding tools, a minimum 0.002” (0.0508 mm) shear gap is to be maintained when the tool is closed to stops to prevent die lock shear damage.

3. Shear edge height is to be 0.5” (12.7 mm) minimum (relative to press closing direction) for both core and cavity.

4. Spotting of the shear edges is to be performed with both core and cavity within 5ºF (2.8ºC) of the tool’s intended operating temperature. The tool temperature differential used during spotting should also mimic the intended process.

5. Shear edges on the cavity should be benched to 320 grit minimum (240 grit minimum for cores) after spotting and prior to chrome plating to prevent flash adhesion and potential part damage upon demold. An additional polishing step is required on the chromed surface unless the pre-chromed shear edge is benched to 400 grit or better. Diamond polish may be used to obtain even high levels of finish. All shear edge benching should be performed in the direction of draw to further encourage flash removal.

6. Final sign-off on a tool prior to being chromed is contingent upon the measurement of flash on the molded parts from tooling trials. Sign-off is to occur only when all flash measurements are between 0.003” and 0.007” (90.0508 mm and 0.1778 mm) for tools with both cavity and core to be chromed. For tools having only the cavity chromed, flash measurements should fall between 0.0025” and 0.0065” (0.0508 mm and 0.1524 mm). If the cavity, core or both are chromed prior to molding trials (i.e. to prevent die wear), these tolerances will be different. If only one half of the tool is chromed prior to molding trials, 0.0005” should be subtracted from the above tolerances. If both halves of the tool are chromed prior to molding trials, 0.001” should be subtracted.

7. Core and cavity shear edges should be flame hardened prior to final chroming.

8. Except in situations where the core is left unchromed, shear edges for both core and cavity should be chrome plated or coated/hardened in a similar fashion to prevent routine erosion from material flow. Chrome plating is to be 0.0005-0.0010” (0.0254 mm).

9. Wear plate tolerance should be 0.000-0.003” (0-0.076 mm) and can be checked by placing masking tape on the heel block, closing the tool, and verifying that the tape has been sheared.

SMC Molding Process Design

1. Charge patterns should be optimized to balance mold filling as well as to maximize surface appearance and mechanical properties. Failure to do this will result in premature shear edge wear from excessive glass in the flash and an increase in edge pops due to fiber pulls and exposed fiber bundles at the part edge. A current industry practice entails intentional opening of shear gaps in localized areas of parts to foster air release in areas where porosity is problematic or to encourage flow of in mold coating. This practice should be avoided if possible, and charge pattern optimization and edge-of-part-design should be used to remedy these problem areas.

2. Press parallelism must be maintained to prevent shear edge contact damage during mold closure. Parallelism requirements must be determined on a part-to-part basis based primarily upon the features of the press and size of the mold in question. For large parts with a tendency for deflecting the platen during mold filling, press self-leveling mechanisms should be used.

3. Each Class “A” SMC part should have regions along its edges categorized as Class “A” or non-Class “A” edges. Within these regions zones should be strategically selected based upon shear edge condition or part geometry. The following procedures outline the measurement requirements for two types of data collection: routine and comprehensive measurement of SMC flash data. A diagram of the part with zones clearly indicated should be constructed for recording data for comprehensive flash measurement.

Routine Flash Measurement

1. The following events will result in the measurement of SMC part flash (closest to the part) in strategic locations for one part. Strategic locations are defined as predetermined points along Class “A” edges. These locations should be no greater than 18” apart.

   - Tool installed into a new/different press (i.e., die change)
   - One week elapsed since last routine flash measurement
   - Appearance of excessively thick flash or excessive fiber in flash on any area of the part. Flash measurements should be made in the visible thick areas as well as in the predetermined strategic locations.

2. A micrometer or other specially designed tool (rather than calipers) should be used for flash measurement. Micrometers offer the ability to measure smaller areas and span flash areas of unimportance to get to the near-part-edge position of the flash. The resolution on the micrometer should be at least 0.0001”.

3. The data from each one-part measurement will be recorded on the press setup sheet or other appropriate form, which indicates location number and 0.010” maximum specification.

Comprehensive Flash Measurement

1. The following events will result in the measurement of SMC part flash (closest to part) at 3-6” intervals for the entire perimeter of three consecutively molded parts. Each measurement location should be at the same point for all ten parts. Single part, point, or edge measurements are not supported by this set of procedures. Individually measurements provide no indication of gross tool shifts or shear wear patterns and should not provide the basis for any tooling repair.

   - 10,000 parts molded since the last three part flash measurements
   - Three months elapsed time since the last three part flash measurements
   - Routine flash measurement (above) results in an individual measurement greater than 0.010”
   - Any aspect of the process changed which may affect shear edge gap
   - Appearance of die wear or impact damage to core or cavity shear edge

Tool Shear Edge Repairs

Mold repairs should be made based upon the following guidelines:

- New weld stock should be added to any measurement point(s) having a mean value greater than 0.010” (0.2540 mm) from either routine or comprehensive flash measurement.

- Weld stock addition to the zone of interest or heel block adjustment should be performed when any zone has a mean flash measurement greater than 0.006” (0.1524 mm) based upon the zone trend chart data. This allows for isolated points to have shear gaps between 0.006 – 0.010” (0.1524 – 0.2540 mm). If heel block adjustment is performed, new flash data should be taken (ten parts, 6” intervals, all areas of tool) and maintenance performed accordingly.

1. A log of all repairs made to the shear edges of each SMC mold is to be kept. The log will detail date, shift, flash measurement in area(s) of repair(s), repair technician/company, and comments on the repair.

2. All repairs will result in the repaired area falling below the 0.006” (0.1524 mm) shear gap tolerance.

3. Wear plate tolerances should be checked using the masking tape method prior to any heel block adjustment. Wear plates may be adjusted up to a cumulative maximum of 0.005” (0.1270 mm) in any one direction providing the adjustment results in an in-specification shear gap for the edge (2) being adjusted. If the 0.005” (0.1270 mm) maximum is reached, the heel blocks are to be adjusted back to their original position (as determined from the heel block adjustment records in the tooling repair log) and weld stock added to the necessary edges based upon the new flash thickness measurement. Any wear plate adjustments should result in the adjustment of the opposing wear plate(s) to ensure the 0.000” – 0.003” (0-0.076 mm) tolerance is met for all wear plates.

4. Weld stock grades should match the parent steel.

5. Shear edges should be benched to a 400-grit finish in all repaired areas.

6. It is highly recommended that the tool be stripped and rechromed after any full shear refurbishment to reduce future shear repair frequency.

7. Spotting of repaired shear edges should be performed with both core and cavity within 5ºF (2.8ºC) of their intended operating temperatures.

8. Original shear edge geometry (i.e., draft angles, shear height) should be maintained during any repair.

ACA
BEST PRACTICES

MOLDING GUIDELINES TO IMPROVE SURFACE APPEARANCE

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1. Charge patterns are cut using slitters, die cutters and manually with knives. The operator places various pieces of material in the pattern according to diagrams and specifications. The layout pattern is developed during mold tryout. The methods used include part mass analysis, edge flow analysis using dyed edges, and intentional short shots with mold shims.

2. The SMC carrier film is removed during cutting and charge layout. the material begins to lose styrene and harden when exposed to the atmosphere. Poor flow and under-cured material can result. Operating procedures specify covering material if not used immediately or discarding material if exposed too long.

3. Part geometry, especially deep draws and angles, greatly affects the ability to completely cover the part during in-mold coating. The coating seals against potential defects and provides primed surfaces for painting. Industry design guidelines exist documenting the optimal design parameters. For difficult parts, some internal guidelines provide “rule-of-thumb” points to assist in developing the coating process.

4. On certain mold presses, a vacuum is applied to the mold cavity to evacuate air prior to completing mold closure. The vacuum level is monitored at the press accumulator. The material flow can be disrupted if the cavity is not properly evacuated. The gasket material (Viton or silicones) can be easily damaged and wears from contact with the sliding mold. Proprietary seal designs and systems exist at several vendors that improve sealing. Gauges can be installed in the mold opposite the vacuum ports to optimize timing and duration during setup.

5. Either manual or automatic charge placement can be utilized. Due to dedicated tooling required to automatically place the material charge, low-volume parts are frequently positioned manually. During part launch the position may be varied to optimize different part characteristics. One finalized, the position is either etched or stained onto the mold, but both wear out over time. Diagrams and training are also provided to the dedicated mold operators. It is imperative that difficult parts be precisely and automatically loaded into the mold cavity.

6. For low-volume SMC parts, bonding adhesive may be applied by an operator. A specified pattern is required to guarantee sufficient bonding strength. Diagrams showing the patterns are provided. Adhesive application is usually automated using robots with dispensing heads that can maneuver in many patterns through the robot programs.

7. Parts that require precise location or have match shaped features are frequently difficult to assemble. The difficult assembly can smear adhesive and can misalign the parts. The resulting assembly may be out of tolerance or structurally weak. Destructive teardowns are performed at regular intervals. Physical dimensions are also checked at regular intervals. Ideally the assembly should be performed using automation. Also, bond joints should be designed to eliminate potential smearing.

8. Some parts are placed together by operators. Misaligned parts can result from poor technique. The resulting assembly may be out of tolerance or structurally weak. Destructive teardowns are performed at regular intervals. Physical dimensions are also checked at regular intervals. Part and assembly diagrams are provided to the operators. Some parts allow for raised ribs to be molded into the part to assist with location.

9. Four methods are used to cure the bond adhesive: heated blocks, RF coils, directed hot air flow and ovens. Inconsistent heating can result in weakened bond areas and partial curing. The most common method, heated blocks, is tied into direct control loops that monitor temperature. The use of thermal imaging during the process setup will verify consistent heating on bond line areas. Directed hot air flow offers increased flexibility, reliability and speed. Jets have the flexibility to be redirected or additional jets can be incorporated for trouble areas.

10. Operators often position bonded assemblies on the curing nests. Correct placement ensures good thermal contact with the heated blocks, correct directed hot air flow and relationship to other heating elements. Curing nests should incorporate part proximity switches to ensure complete seating.

11. The bonding fixture seats the mating parts to a fixed stop position. The part thickness determines the spacing for the adhesive. The profile of the cured adhesive will fill the void space, providing sufficient adhesive is applied. Adhesive beads are used to ensure contact with both mating parts. Charge weights should be regularly monitored to ensure they are made to tolerance (± 0.25 mm).

12. Unpainted SMC parts are inspected prior to prime and paint application. The operators identify and repair any surface defects. Some surface defects are not visible (such as waviness, bond lines, etc.) to the naked eye and therefore, can pass inspection. Random parts are pulled for Diffracto inspection, a method that involves applying a glossy substance to the part prior to secondary inspection. However, this system does not always detect certain defects and feedback to molding and painting is not optimal.

13. Painted SMC parts are inspected by operators after prime and paint application. The operators identify and repair surface defects, then send reworked parts through the paint system again. Some surface defects are not readily detectable (such as waviness, bond lines, etc.) to the naked eye and pass inspection. Random parts are pulled for inspection by Diffracto analysis. This method also does not always detect certain defects, and feedback to molding and painting is not optimal. Enhanced lighting systems and methods such as the Visual Performance system, will further help detect defects.

14. During the paint process, operators apply paint to hard-to-reach areas, during touch up operations, and serve as backup to automated equipment. Because each individual sprays the paint slightly differently, runs, drips, sags, thin areas, orange peel and over spray can result. All operators must be certified and receive training on paint applications according to the ACA SMC paint guidelines. Robot articulated paint application allows multi-directional spraying and reduces the number of operators needed to handle hard-to-reach areas.

15. Unpainted SMC parts are inspected by the operators prior to primer and paint application. The operators identify and repair surface defects. Cycle time for each part is determined through molding. Limited time frame can impact thoroughness of inspection, particularly on larger or more complex parts. Random parts are pulled for Diffracto inspection. Operators are provided training on defect detection and recent problems. Detect display boards and scrapped parts with highlighted defects are also provided for comparisons and teaching. Operators have access to light wands to further illuminate the part surface.

16. The operators identify and repair surface defects after painting. The operators are trained on the methods to correct common defects. Defect boards and highlighted scrapped parts are available for comparison. When operators sand through to raw SMC, an air-dry primer is used to retouch the parts. The air-dry primer can lead to other paint defects. Continuous operator training and the use of approved materials (sandpaper, adhesives, spray materials) can help to minimize sanding and repairs.

PopFree®
Primer/Sealer for Plastic Substrates

The PopFree® product line consists of three basic 2K primers specifically designed to seal porosity and cracks common to many plastic substrates. PopFree® is available as a non-conductive black (UAE-9813), conductive back (UAE-9816) and conductive gray (UAE-2560) primer.

The greatest benefit of using PopFree® is the emanation of out-gassing during topcoating. PopFree® seals voids and cracks which are the source of out-gassing. This problem is quite common, especially with glass-reinforced thermoset plastics such as SMC, BMC, and RTM.

Substrates

Various FRP, SMC, BMC, BRIM, RTM
RIM & SRIM
Nylon blends
ABS
ABS/PC blends
Others

Applications

Hand guns
Robotics
Bells

Cure

160º to 330º F

Benefits

Prevents out-gassing
PP15-1)
Levels to a superior finish
Resists sagging
Resists soak-in
Cures at a wide range of temperatures
Eliminates need for In-mold coating
Adheres to a wide array of plastics

OEM Approvals

Daimler-Chrysler (MS-PP7-2 &MS-Possesses excellent holdout

Ford (ESB-M6J106-C)
GM (998-4803 & 998-4804)
Case (MS47)
Freightliner (49-00087)
New Holland (FNHA-2-j-069.00)

PopFree® and E-Coat Applications

PopFree® has been tested for applications involving a combination of SMC and steel body panels. The pre-assembled body goes through an electro-coat dip and bake. The high temperature e-coat cure cycle (45-60 minutes @ 365º - 400ºF) has not had any deleterious effect on the performance of the PopFree® primer/sealer.

Attached is a test matrix of e-coat bake versus control bake performance of PopFree® per Ford specification, ESB-M6J106-C1.

Currently, PopFree® is being used in several Ford plants that use e-coat:

- Wixom – Lincoln Continental hoods, fenders, & deck lids.
- Michigan Truck – Navigator hoods
- Twin Cities – Ranger hoods
- Edison – Ranger hoods
- Ste. Therese – CF4 Doors

PopFree® Product List

		60º Gloss	Application
CONDUCTIVE GRAY:			
	UAE-2560	~10	W-O-W, 180º-330ºF & Industrial, stand-alone, ≤ 240º F Repair, air-dry or IR
	UAE-2560L	20–40	Stand Alone, 180º - 240º F
	UAE-2560NT	20-40	Stand-alone, 240º - 300º F
	UAE-2560E	40-60	Stand-alone, exempt 240º - 300º F
	UAE-2560ET	40-60	Stand-alone, exempt 180º - 240º F
CONDUCTIVE BLACK:			
	UAE-9816	40-60	Stand-alone, 180º - 240º F
	UAE-9816NT	40-60	Stand-alone, 240º - 300º F
	UAE-9816E	40-60	Stand-alone, exempt 240º - 300º F
	UAE-9816ET	40-60	Stand-alone, exempt 180º - 240º F
NON-CONDUCTIVE BLACK:			
	UAE-9813	~10	W-O-W, 180º-330ºF & Industrial, stand-alone, ≤ 240º F

CURING PARAMETERS FOR POPFREE®

As a sealer under BP-2349 (1K) primer (wet-on-wet):

1) Using a conventional air-atomized spray gun with a 797 cap, apply PopFree® at approximately 3 wet mils (~1 dry mil).
2) Flash a minimum of one minute (or until the film looks nearly dry). There is no maximum room temperature flash time.
3) Apply BP-2349 primer as normal.
4) Cure part as normal for BP-2349 primer – typically part temperature of 285ºF for 20 –25 minutes.

As a stand-alone primer/sealer:

1) Apply PopFree® @ 3- 4 wet mils (1 – 1.5 dry mils). (Some substrates or circumstances may require more PopFree®. Adjust film build as necessary.)
2) Flash a minimum of ten minutes. There is no maximum room temperature flash time.
3) Cure parts in a convection oven up to 240ºF oven temperature for conventional PopFree® or as high as 330ºF with "NT" versions. A 20-40 minute bake window is ideal. A relatively slow ramp-up is best for optimal sealing performance.

Note: PopFree® works very well as an air-dry primer/sealer also. An overnight air dry may be desired for some (usually non-automotive) applications.

As a spot repair primer/sealer:

1) Scuff sand repair area with 400 grit or finer paper or fine Scotch Brite®
2) Clean with an appropriate solvent and allow to flash.
3) Apply 3 –4 wet mils of PopFree®.
4) Flash at least ten minutes (or until dry-to-touch), before racking part
   OR
   Cure in an infrared oven 6 – 15 minutes @ 180º - 220ºF.

Reducing PopFree®

1) Wet-on-Wet:

Wet-on-wet refers to an application of PopFree®, followed by a short flash and then an application of 1K primer. This technique is often difficult to implement and requires at least two spray booths in series. The minimum flash time is 60 seconds (or when the PopFree® has flashed dry).

Often, it is only desired to coat the troublesome pop/pit areas such as edges. This saves on PopFree® usage, however, it may introduce other problems, especially dry over-spray on the "A" surface.

We normally recommend UAE-2560 or 9813, reduced solely with MAK (10-20%). These products flash very quickly, enabling sufficient set-up time before the 1K application. The other PopFree® products have a slower solvent package and usually flash too slow for successful w-o-w scenarios.

2) **Stand-alone:**

Essentially all PopFree products can be used as stand-alone primer/sealers. The UAE-2560 and 9813 are the fastest flashing products; they also have the lowest gloss (~10), which generally limits their usage to industrial applications.

The remaining PopFree® products have higher gloss (>40) and are well suited for **automotive applications.** For most paint facilities with conveyor systems, slow reducers are recommended to achieve the smoothest paint film. **We usually reduce 15 – 20% with a solvent blend that includes at lest 50% DB-acetate. DBA keeps the film wet long enough to minimize dry over-spray.** One side effect of DBA is gloss reduction.

When VOC Levels aren't a concern, reduce stand-alone PopFree® 15 – 20% with one of the following solvents or blends:

MAK
PM-acetate
Cyclohexanone
EEP
DBA (a.k.a. Butyl Carbitol Acetate)
DBA/MAK blends

When VOC levels are limited, the "E" (exempt) versions of PopFree® are required. The "E" formulations incorporate a VOC exempt solvent. The package VOC is approximately 3.5 lbs/gal. These products are typically reduced to spray with an exempt solvent (currently Oxol® 100 or equivalent) or a blend of DBA and exempt solvent (as the permit allows).

The biggest downside of the "E" formulas is the price. The current useful exempt solvent is Oxol® 100, which is very expensive. Typically, the "E" products sell for $10/gal. more than the non-exempt products.

3) Choose reducers wisely:

Reducer choice should be based on the limitations of the production paint booth(s). **Ideally, it’s always best to use only MAK when possible for a relatively fast flash-off time.** The faster the solvent leaves the coating before it reaches bake temperature, the better.

PopFree® is most effective as a sealer and pop suppressor when it can quickly form a solvent-free film before reaching bake temperature. Therefore, **the more complete the flash-off (evaporation of solvent in the film) before reaching elevated temperatures, the better the chance of good sealing.**

For the same reason, **paint facilities can improve the sealing abilities of PopFree® by extending flash times and adjusting the oven stages for a gradual ramp-up in temperature.**

APPROVALS:

FORD	ESB-M6J106-C
GM	998-4803 (edges) & 998-4804 (stand alone)
CHRYSLER	MS-PP7-2 (FRP) & MS-PP15-1 (Viper)
CASE	MS47
NEW HOLLAND	FNHA-2-J-069.00
FREIGHTLINER	49-00087

CURRENT CUSTOMERS:

ABC
BREKMAR
BUDD – Kendallville & N. Baltimore
MASTERMOLD, Mauston
MATLAB
MERIDIAN
MERIDIAN – Grabill, Jackson, Salisbury, Shelbyville
PASDA, MEXICO
PEMSA, Mexico
VENTURE, Lancaster

CURRENT END USES:

ABC
- Pontiac – spoilers (Noryl, changing to ABS)

BREKMAR
- New Holland and Case body panels.

BUDD
- Continental – hoods, deck lids & fenders
- Mustang – hoods & deck lids
- Navigator – hoods
- Ranger – hoods
- T-bird – hoods, deck lids & fenders
- Camaro/Firebird – doors
- GM truck – fenders, tailgates (RIM, repair only)

MASTERMOLD
- Harley – saddlebags

MATLAB
- New Holland Tractor – hoods & fenders
- BMW – seat backs

MERIDIAN
- Mitsubishi – spoilers
- Hummer 2 – hoods
- Viper – body panels (prototypes)
- Sterling – hoods

PADSA
- Chevy truck – tailgates

VENTURE
- Corvette – quarter panels, roof panels & fuel doors
- Mustang – A & C pillars
- Case tractor – various body panels
- General – various automotive service parts

RED SPOT WESTLAND, INC.

550 S. EDWIN – WESTLAND, MI 48186 – Phone: 734/729-7400 – Fax: 734/729-6140

Date 2-28-01
Supercedes 9-27-00

PopFree® UAE-2560/XM-0226

Product Data

Component A Code	
Component B Code	
Type of Product	PopFree® Gray Conductive - Porosity Sealing Primer
Color	Gray
Typical Use	Sealing and Priming for Fiberglass Reinforced Plastics.

Physical Data

	Component A	*Component A+B*
Package Visc. @#4 FC	40-50 sec.	40-50 sec.
Weight/Gallon*	9.64 lbs/gal	9.57 lbs/gal
% Weight Solids*	51.66%	53.65%
% Volume Solids*	31.08%	34.50%
% Gloss	Not Applicable	Less than 16 @ 60° Glossmeter
Conductivity	Not Applicable	140 minimum
Package V.O.C.*	4.66 lbs/gal	4.44 lbs/gal

*Theoretical Data

Application Data

	Component A+B
Method of Application	Spray - 2K Mix at the Gun Equipment Recommended
Application Viscosity	Same as Package
Reduction/Thinner	0-10% / MAK Only if Necessary
Substrate	Various FRP
Clean-up Thinner	Xylol or Equivalent
Curing Conditions: As Sealer	1) Wet-on-Wet with Approved Conductive Primer. 2) Target 30' @ 180°F to 16 Hr. A/D.
As Standalone Primer	Target 20' @ 210°F Part Temperature(See Bake Chart)
Flash Time	System Dependent
Dry Film Thickness	Target 1.0, Range 0.8 - 2.0 mil

Mixing Instructions:

Component A: UAE-2560	Volume: 10	Weight: 150 grams
Component B: XM-0226	Volume: 1	Weight: 13.8 grams

Mixing ratio should not vary more than 5% from mixing instructions
Cure Check = 10 Double Rubs with Isopropyl Alcohol per GM9509P (0 to 1 Rating)

Component A Shelf Life = 6 months from date of purchase
Component B Shelf Life = 3 months from date of purchase in unopened containers @ 77°F. Note: Keep free from all moisture.