

MASKING MATERIALS FOR PREVENTING HOT-DIP GALVANIZING

BY BERNARDO DURAN, III AND THOMAS LANGILL, PhD

BACKGROUND

Masking materials, also called stop-off materials, are products applied to steel in specific areas prior to hot-dip galvanizing to prevent zinc from reacting with and adhering to the steel.

Masking is done for a myriad of reasons. For example, sometimes it is preferable to prevent galvanizing on large areas of steel that will be welded, rather than removing the zinc coating later. Masking materials are also sometimes applied to

threads when precise fit is necessary and the additional width of the galvanized coating would cause fit issues. Another reason to mask steel is to give a higher slip factor on some faying surfaces.

Many different types of products have been used as masking materials. Some products are specifically designed for the purpose of preventing galvanizing, and other products from other industries or for other uses have been found to work

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well at masking steel prior to galvanizing.

INTRODUCTION

An American Galvanizers Association (AGA) study was conducted to determine the effectiveness of masking materials at preventing adhesion of zinc to steel during galvanizing.

This study is important because masking materials are commonly used, and until now, there was no definitive study that looked at the efficacy of various products used to prevent galvanizing.

The information obtained in this study will give galvanizers and fabricators detailed facts on the performance of various masking materials, as well as provide data on application and removal of the masking materials after hot-dip galvanizing.

TEST PROCEDURE

In this study 15 masking materials were tested. Some of these materials are currently used to mask steel, and others have been used in the past with some success. In addition to past performance, the products were chosen based on their

availability and recommendations from AGA members.

The study consists of two phases. The goal of Phase 1 testing is to determine the effectiveness of the various masking products in masking the steel surface from zinc. The products that successfully masked steel in Phase 1 were included in Phase 2 testing. The goal of Phase 2 is to determine the performance of the successful materials from Phase 1 testing when given shorter cure times. Attempting to restore the original appearance of the steel (by chemical cleaning) is also a goal in Phase 2.

The masking materials were tested on three different types of surfaces; flat plate, buried threaded holes, and bolt threads. Two types of flat plate were used in the study. The first type of flat plate (see *Figure 1*, next page) was approximately 3" x 6". The masking materials were applied to the steel away from the hole. The masking area had a width of 3" and a length of a little less than 4".

All masking materials were applied to the steel prior to the cleaning steps of the

galvanizing process, meaning the masking materials were subjected to a caustic bath, pickling bath, and flux bath. It was important to determine if the masking materials could survive the cleaning chemicals, because if they could survive, the masking materials could be applied at the fabricator's facility, and thereby save the galvanizer the time and trouble of applying the materials.

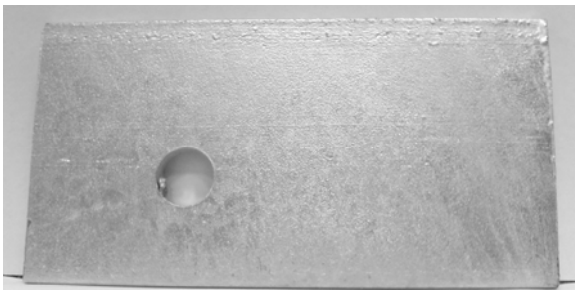


Figure 1: Flat Plate

Some of the plates were drilled and tapped to provide a plate with a buried threaded hole to test the masking materials (see *Figure 2*). The buried threaded holes were 2½" deep holes drilled into a 3" thick plate (see *Figure 2*). Buried threaded holes were used only in Phase 1 testing. The bolts used in the study were ¾" in diameter and approximately 2 ½" in length (see *Figure 3*).



Figure 3: Coated Bolt Threads



Figure 2: Buried Threaded Holes Plate

The masking materials were applied to the plates with a foam brush and then spread in the masked areas until an even consistency was achieved.

For the buried threaded holes the masking products were simply poured or squeezed into the holes.

For the bolt threads, the masking materials were applied by either dipping

the bolts directly into the bottle of the material, if there was enough room, or spread onto the threads using a foam brush. The material was spread onto the threads to achieve even thickness.

The masking materials for all surface types were applied prior to the chemical cleaning steps of the galvanizing process. This ensured the masking materials could stand up to the cleaning agents and would remain on the steel prior to galvanizing.

Masking products were removed by using a metal-bristled brush. The materials were scrubbed off the surface and then compressed air was used to blow off the debris. In Phase 2 testing, scrubbing the cleaned steel with a nylon bristled brush and Simple Green solution was also performed to determine if the original steel finish could be restored. A grinder was also tested in Phase 2 for removing the materials on flat plate.

PHASE 1 TESTING

MASKING MATERIAL TESTING

Fifteen different masking materials were tested in Phase 1, including:

- Duct Tape
- Kapton Tape
- VHT Header Paint (tested only on flat plate)
- Dow Corning Compound #111
- DAP Household Adhesive Sealant
- Stop Galv
- NAPA RTV Red
- GE 100% Silicone Caulk
- Galva Stop
- Valmont Masking Compound
- Macropoxy 846
- 3M High Temperature Aluminum Tape
- Maskote Zinc Stop-Off
- ZYP Boron Nitride Lubriccoat
- ZYP Boron Nitride Hardcoat

Determining the effectiveness of each masking material came down to observing how much of the masked area galvanized. The smaller the area that galvanized, the more effective the masking material.

For flat plate, greater than 90% of the masked area had to remain ungalvanized to proceed to Phase 2 testing. For buried threaded holes, almost the entire

threaded area needed to remain free of galvanizing. If a few small spots of zinc were observed, the masking material was still considered effective. For bolt threads, the same criteria applied as that for buried threaded holes – almost the entire threaded area must remain ungalvanized to be considered effective.

TEST 1 RESULTS

On the flat plate, nine products failed to prevent galvanizing on a minimum of 90% of the masked area. Six products successfully prevented zinc coating a minimum of 90% of the masked area on flat plates including:

- Stop Galv
- Maskote Zinc Stop-Off
- NAPA RTV Red
- Galva Stop
- GE 100% Silicone Caulk
- Valmont Masking Compound

Only 14 of the masking materials were tested on buried threaded holes and bolt threads. The VHT Header Paint was not tested because paint cannot be easily removed from threaded areas.

Eight products failed to prevent zinc coating on the buried threaded holes.

Six products successfully prevented zinc coating on the buried threaded holes, including:

- DAP Household Adhesive Sealant
- GE 100% Silicone Caulk
- Valmont Masking Compound
- Maskote Zinc Stop-Off
- Macropoxy 846
- ZYP Boron Nitride Hardcoat

Six of the 14 products failed to prevent galvanizing on bolt threads. The masking materials that did prevent zinc coating on bolt threads include:

- Galva Stop
- Stop Galv
- DAP Household Adhesive Sealant
- NAPA RTV Red
- GE 100% Silicone Caulk
- Macropoxy 846
- Maskote Zinc Stop-Off

The bolts masked with Valmont Masking Compound were lost during the galvanizing process during testing.

For more detailed information on how each masking material performed on the various surface types, and application

and removal data, please see the charts in Appendix 1.

PHASE 2 TESTING

SHORTER CURE TIME TESTING

AND CLEANING

The first goal of Phase 2 testing was to determine how the products that performed well in Phase 1 testing performed were applied using shorter cure times. Products tested in Phase 2 included:

- Stop Galv
- Galva Stop
- Maskote Zinc Stop-Off
- NAPA RTV Red
- GE 100% Silicone Caulk
- DAP Household Adhesive Sealant

Although Valmont Masking Compound did well in Phase 1 testing, it was not included in Phase 2 testing. Also, as mentioned earlier, buried threaded holes were not tested in Phase 2.

Shorter cure times were tested in Phase 2. These tests demonstrated the limits of the masking materials. However, it is important to note these materials should be used in accordance with the

manufactures curing instructions to achieve optimum performance.

The second goal of Phase 2 testing was to determine if the original steel finish could be restored after removing the masking materials from the steel.

The criteria for determining the effectiveness of these masking materials in Phase 2 testing was the same as in Phase 1 Testing. Ninety percent or more of the masked area on plates had to remain free of galvanizing to be considered successful. For bolts, only a few small areas of zinc on the masked threads were allowed for the material to be considered successful.

For the flat plate specimens, each masking material was applied to the same areas used in Phase 1 testing. The plates had been stripped of all zinc and remaining residues from Phase 1 testing. Masking products were applied to only one side of the plates to decrease application time. Cure times included 1 and 2 hours for flat plate specimens.

For bolt threads, the masking materials were applied to the same bolts as those

used in Phase 1 Testing. The bolts had been stripped of all galvanizing and debris from the Phase 1 tests. Three different cure times were tested on the bolt threads; 30 minutes, 1 hour, and 2 hours.

For both the flat plate specimens and the bolt thread areas, cleaning the baked on masking materials after galvanizing was attempted by scraping the steel with a metal-bristled brush and then scrubbing with a nylon brush and Simple Green solution (see *Figure 4*). The goal of cleaning with the Simple Green solution was to determine if the original finish of the steel could be restored after the various masking materials had baked on the surface while going through the galvanizing process. Cleaning with a grinder was attempted on the flat plate specimens only.



Figure 4: Simple Green and Nylon Brush

TEST 2 RESULTS

FLAT PLATE

For the 1 and 2 hour cure times only Stop Galv and Galva Stop were successful at preventing galvanizing.

Some ashy material from Stop Galv and Galva Stop remained on the plates even after scrubbing with a metal-bristled brush.

Cleaning the plates with the Simple Green solution had a negligible effect on removing the debris left from the masking materials.

Using a grinder to remove the baked-on masking materials was excessive and is not recommended. The grinder immediately went through the masking materials and attacked the steel underneath.

BOLT THREADS

Three different cure times were tested for each masking material on bolt threads, including 30 minutes, 1 hour, and 2 hours. For the 30 minute cure time Galva Stop and NAPA RTV Red were the only products that successfully prevented galvanizing.

For the 1 hour cure time, five of the six masking materials were successful at preventing galvanizing, including Galva Stop, Maskote Zinc Stop-Off, DAP Household Adhesive Sealant, NAPA RTV Red, and Stop Galv.

For the 2 hour cure time all six masking materials successfully prevented galvanizing on the bolt threads.

After galvanizing, a metal-bristled brush was used to scrape the big chunks of baked-on masking material from the threads. A Simple Green solution and nylon brush were then used to remove the remaining baked-on debris. The appearance of the bolt threads was improved for all the masking materials after cleaning with the Simple Green solution.

The cleanest bolts were those masked with Maskote Zinc Stop-Off, GE 100% Silicone Caulk, and DAP Household Adhesive Sealant. It was necessary to wash the bolts masked with NAPA RTV Red twice because of the gummy residue. Some baked on masking material remained on the bolts masked with Galva Stop and Stop Galv.

Cleaning with the Simple Green solution was done after the 1 hour curing time. If the masking materials had been given their full recommended curing time it is likely the products would have been easier to remove and would have cleaned even better.

Cleaning the masking materials from the bolt threads with a grinder was not attempted because it would damage the threads.

CONCLUSION

The goal of this study was to determine which commercially available masking materials work best at preventing galvanizing on masked areas.

Six commercially available masking materials were identified to successfully prevent galvanizing on one or more surface types, including flat plate, bolt threads, and buried threaded holes. The successful masking materials included (in no particular order):

- Stop Galv
- GE 100% Silicone Caulk
- Maskote Zinc Stop-Off
- NAPA RTV Red
- (cont. on next page)

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- Galva Stop
 - DAP Household Adhesive Sealant

Additional and detailed performance data is presented in the charts in Appendix 1 and additional pictures are presented in Appendix 2.

SAFETY AND HEALTH INFORMATION

Material Safety Data Sheets (MSDS) should be obtained and adhered to when using these materials. Necessary personal protective equipment should be employed when appropriate. Almost all of these masking materials had nauseating smells and should be used only in well ventilated areas. It is important to note some of these products were not designed to be used in the temperature ranges of the galvanizing process.

COSTS OF THE MASKING MATERIALS

The masking materials tested in this study have a wide range in price, which can be found in Appendix 1. In addition to the purchase price, additional costs to be considered include labor time for applying and removing the materials. Detailed application and removal times are included in the charts in Appendix 1.

Appendix 1.
Detailed Performance Data of Masking Materials

PHASE 1 TESTING - OVERVIEW OF SUCCESSFUL MASKING MATERIALS

			FLAT PLATE			BURIED THREADED HOLES			BOLT THREADS		
Product	Price	Standardized Price	Success	Application Time	Removal Time	Success	Application Time	Removal Time	Success	Application Time	Removal Time
DAP 100% Silicone Adhesive	\$3.98 / 2.8 oz. tube	\$1.42 / oz	-	N/A	N/A	Yes	6 mins., 30 secs.	12 mins., 5 secs.	Yes	9 mins., 30 secs.	4 mins., 22 secs.
Galva Stop	\$48.00 / liter	\$1.42 / oz	Yes	2 mins., 21 secs.	2 mins., 38 secs.	-	N/A	N/A	Yes	3 mins.	6 mins., 50 secs.
GE 100% Silicone Caulk	\$4.97 / 10.1 oz. tube	\$0.49 / oz	Yes	1 min., 22 secs.	1 min.	Yes	1 min., 15 secs.	5 mins., 18 secs.	Yes	10 mins., 30 secs.	7 mins., 30 secs.
Macropoxy 846	\$89.78 / gal. of Part A & B	\$0.35 / oz	-	N/A	N/A	Yes	32 mins., 26 secs.	8 mins., 40 secs.	Yes	37 mins., 10 secs.	1 min., 11 secs.
Maskote Zinc Stop - Off	\$120.00 / gal.	\$0.94 / oz	Yes	2 mins., 37 secs.	1 min.	Yes	5 mins., 13 secs.	3 mins.	Yes	5 mins., 12 secs.	3 mins., 5 secs.
NAPA RTV Red	\$14.19 / 11 oz. tube	\$1.29 / oz	Yes	1 min., 32 secs.	1 min.	-	N/A	N/A	Yes	9 mins., 45 secs.	4 mins., 18 secs.
Stop Galv	\$45.00 / qt.	\$1.41 / oz	Yes	4 mins., 26 secs.	5 mins., 48 secs.	-	N/A	N/A	Yes	5 mins.	10 mins., 20 secs.
Valmont Masking Compound	\$4.75 / small tube	\$0.37 / oz	Yes	2 mins., 32 secs.	1 min.	Yes	10 mins., 30 secs.	5 mins., 28 secs.	-	N/A	N/A
ZYP Boron Nitride Hardcoat	\$170.00 / gal.	\$1.33 / oz	-	N/A	N/A	Yes	3 mins., 24 secs.	7 mins., 52 secs.	-	N/A	N/A

FLAT PLATE - PHASE 1 TESTING

Product	Application Time	Application Notes	Masking Success	Notes	Removal Time	Removal Notes
3M High Temperature Aluminum Tape	17 mins., 26 secs.	Thoroughly ensured the edges were sealed.	Almost	About 12% of the area galvanized. Seepage at ends caused galvanizing in those areas.	9 mins., 24 secs.	Used a flathead screwdriver to scrape the tape and then pulled it off.
DAP Household Adhesive Sealant	3 mins., 20 secs.	Squirted the product onto plates, then spread it with a foam paint brush. Material was very easy to work with.	-	One plate galvanized completely and the two other plates had large areas that galvanized.	2 mins., 11 secs.	Scraped off with a small metal-bristled brush. The material was very gummy and hard to remove.
Dow Corning Compound #111	3 mins., 42 secs.	Squirted the product onto plates, then spread around with a foam paint brush. Material spread easily, but was messy because it does not dry.	-	At least 80% of the area galvanized.	40 secs.	Scraped with a small metal-bristled brush.
Duct Tape	25 mins.	Wrapped 2 times around plates.	-	Less than 90% remained bare	10 mins., 52 secs.	Scraped off burnt tape with a metal-bristled brush. Scraped off very easily.
Galva Stop	2 mins., 21 secs.	Shook can, poured, then spread using a foam brush.	Yes	Entire area was completely free of galvanizing	2 mins., 38 secs.	Used a small metal-bristled brush to scrape since the big metal-brush was ineffective. Had to scrape very hard to get this material off.
GE 100% Silicone Caulk	1 mins., 22 secs.	Used a caulk gun, then spread using a foam brush. Went on very thick.	Yes	The material prevented galvanizing, but the surface was stained black.	1 min.	Used big and small metal-bristled brushes to scrape away the product. It came off fairly easily.
Kapton Tape	30 mins.	2 wraps. Tape did not stick well, much harder to work with than the duct tape.	-	Less than 90% remained bare	18 mins., 39 secs.	Scored tape with a flathead screwdriver, then used a metal-bristled brush to scrape away remaining debris.
Macropoxy 846	32 mins., 14 secs. (31/32 mins. spent on prep time for epoxy)	Poured onto the surface and spread with a foam paint brush.	-	About 15% of the area galvanized	1 min., 37 secs.	Used a small metal-bristled brush to scrape the material off.
Maskote Zinc Stop - Off	2 mins., 37 secs.	Very runny - dries very quickly, making it hard to spread around. Used a foam brush for spreading.	Yes	Entire area was completely free of galvanizing, very clean.	1 min.	Used a big metal-bristled brush. The material came off very easily.
NAPA RTV Red	1 min., 32 secs.	Used a caulk gun, then spread using a foam brush. Went on easy, but kind of thick.	Yes	Almost the entire area remained free of galvanizing	1 min.	Used a big metal-bristled brush to scrape away the material.
Stop Galv	4 mins., 26 secs.	Poured the product on, spread with a foam paint brush. Product went on thick and dried quickly.	Yes	Very slight seepage at perimeters.	5 mins., 48 secs.	Used a small metal-bristled brush to scrape the material off. The material adhered to the surface tenaciously, which required much harder scraping.
Valmont Masking Compound	2 mins., 32 secs.	Very thick, like a paste. Used a foam brush to spread around.	Yes	Entire area was completely free of galvanizing.	1 min.	Used big and small metal-bristled brushes to scrape material off the metal.
VHT Header Paint	1 hr., 33 mins.	Applied 2 coats of paint. Allowed for dry time between coats.	-	All the plates galvanized	N/A - product failed completely.	N/A
ZYP Boron Nitride Hardcoat	3 mins., 48 secs.	Two minutes of application time was to stir the product. Poured onto the surface and spread with a foam paint brush.	-	About 20% of the area galvanized.	2 mins., 32 secs.	The burned product adhered to the steel very well. I had to score it with the edge of a flathead screwdriver and then scrape it with a small metal-bristled brush.
ZYP Boron Nitride Lubricant	4 mins., 16 secs.	Poured onto the surface and spread with a foam paint brush. Material had the runniness of paint and was very messy. 3 minutes of the application time was due to stirring the product like paint.	-	The entire area galvanized.	N/A	N/A

BURIED THREADED HOLES - PHASE 1 TESTING

Product	Application Time	Application Notes	Masking Success	Notes	Removal Time	Removal Notes
3M High Temperature Aluminum Tape	9 mins., 41 secs.	Balled up tape, hammered it into hole using a wooden dowel.	-	4 holes galvanized completely, the other 2 had considerable amounts of zinc in each.	6 mins., 17 secs.	Used flathead screwdriver and small, metal-bristled brush to pry out the tape.
DAP 100% Silicone Adhesive	6 mins., 30 secs.	Squeezed material out of tube and into holes. Hardened like caulk, still flexible. Material remained waxy after 14 hours.	Yes	None of the holes galvanized.	12 mins., 5 secs.	Scraped blob of material out with flat-head screwdriver. Used a metal-bristled brush to scrape the rest of the material out. Consistency of dry caulk. Some small crumbs remained.
Dow Corning Compound #111	3 mins.	Squeezed product out of tube and into holes. The material was very hard to squeeze out of the tubes.	-	4 out of 6 holes did galvanize	3 mins., 50 secs.	Scraped product out with flat-head screwdriver. Hard, flexible consistency like dry caulk.
Duct Tape	5 mins.	Balled up tape, then stuffed in the holes.	-	5 of the 6 holes galvanized	6 mins., 17 secs.	Scraped w/ metal-bristled brush. Some unmasked areas around holes did not galvanize, which could fail inspection after galvanizing.
Galva Stop	2 mins., 30 secs.	Poured into holes	-	In 5 of the 6 holes, a small area galvanized. The area was about 10% of the holes.	8 mins., 26 secs.	Used a metal-bristled brush to scrape material out, which was very hard to do.
GE 100% Silicone Caulk	1 min., 15 secs.	Squirted into holes w/ a caulk gun	Yes	The very top of one hole galvanized a tiny bit, but it could have been an application error, as the hole was not filled to the very top.	5 mins., 18 secs.	Used flathead screwdriver to break apart material, then used a small metal-bristled brush to scrape material out.
Kapton Tape	8 mins.	Slightly harder to work with than duct tape. Balled up, then stuffed in the holes.	-	3 out of the 6 holes galvanized	5 mins., 40 secs.	Used flat-head screwdriver to scrape out tape, then used a metal-bristled brush to get the rest. Some unmasked areas around holes did not galvanize, which could fail inspection after galvanizing.
Macropoxy 846	32 mins., 26 secs.	Preparation time for product took 31 minutes. Poured into holes; very runny and messy.	Yes	None of the holes galvanized.	8 mins., 40 secs.	Used flathead screwdriver to break apart material inside the holes. Material was extremely hard, required considerable force. Used a small metal-bristled brush to scrape out rest of the material, which also required considerable effort.
Maskote Zinc Stop - Off	5 mins., 13 secs.	Poured into holes; runnier than Galva Stop or Stop Galv. Dries faster than other products, too.	Yes	None of the holes galvanized. Holes looked very clean.	3 mins.	Used a small metal-bristled brush to clean material out of the holes. Material came out very easily.
NAPA RTV Red	1 min.	Squirted into holes with a caulk gun	-	2 of the holes galvanized completely, 4 holes galvanized partially.	5 mins., 51 secs.	Used flathead screwdriver to pry out material, then used a small metal-bristled brush to clean the rest of the material out.
Stop Galv	4 mins.	Poured into holes.	-	1 of the 6 holes galvanized	11 mins., 30 secs.	Used a metal-bristled brush to scrub the material out. Holes were charred black inside.
Valmont Masking Compound	10 mins., 30 secs.	Had to cut into the side of the roll, since an industrial size caulk gun was not available.	Yes	In addition to masking intended areas, it caused bare spots in surrounding areas.	5 mins., 28 secs.	Used flathead screwdriver to break apart material, then used a small metal-bristled brush to scrape out remaining material.
VHT Header Paint	N/A	N/A	N/A	N/A	N/A	N/A
ZYP Boron Nitride Hardcoat	3 mins., 24 secs.	2 minutes of application time was due to stirring product. Poured material into the holes. Material dried fast.	Yes	None of the holes galvanized, but there was some frozen zinc inside the holes that had to be wedged out. Wedging out the zinc might not always be possible for all fabrications.	7 mins., 52 secs.	Used flathead screwdriver to break apart hard ash, then used small metal-bristled brush to scrape out the rest. Some small particles remained inside the holes.
ZYP Boron Nitride Lubricant	4 mins., 16 secs.	3 minutes of application time was due to stirring the product. Poured into holes.	-	All of the holes galvanized 100%.	N/A	N/A - all holes galvanized 100%.

BOLT THREADS - PHASE 1 TESTING

Product	Application Time	Application Notes	Masking Success	Notes	Removal Time	Removal Notes
3M High Temperature Aluminum Tape	11 mins., 16 secs.	Wrapped tape around bolts 3 times. Adhesive is very sticky, and difficult to get off roll and apply.	-	Many areas galvanized. Some bare areas, but about half of threads galvanized.	7 mins., 55 secs.	Scraped tape w/ a flathead screwdriver until it could be peeled off.
DAP Household Adhesive Sealant	9 mins., 30 secs.	Very thick, messy. Smelled awful. Smearred on w/ foam paint brush. Dried hard, like caulk.	Yes	A few small areas picked up a little zinc. Got 5 bolts back.	4 mins., 22 secs.	Used big metal-bristled brush to scrape away material. Threads were very clean after scraping material off.
Dow Corning Compound #111	8 mins.	Squeezed material onto threads, smearred on w/ foam paint brush. Had wet, waxy feeling after drying.	-	All bolt threads galvanized to some extent. Got 4 bolts back.	2 mins., 40 secs.	Crusty white material came off very easily w/ a small metal-bristled brush.
Duct Tape	5 mins., 30 secs.	Wrapped 5-6 times around each bolt.	-	Had large bare areas, but many areas still galvanized.	5 mins., 44 secs.	Used a big metal-bristled brush to scrape away the material, which came off very easily.
Galva Stop	3 mins.	Dipped bolts into bottle to apply material. Hardened, but still flexible. Will stick to itself if it touches other coated products.	Yes	A few tiny areas did galvanize.	6 mins., 50 secs.	Brushed off black ashy material very easily with a big metal-bristled brush.
GE 100% Silicone Caulk	10 mins., 30 secs.	Smearred material on w/a foam paint brush. Somewhat easier to handle than NAPA RTV red.	Yes	Threads were completely bare.	7 mins., 30 secs.	Used a small metal-bristled brush to scrape away the material, which came off pretty easily.
Kapton Tape	6 mins., 30 secs.	N/A	-	Could not remove masking material. One bolt was lost during the galvanizing process.	Tape was nearly impossible to remove from threads	Unable to remove tape from threads. This material would not work as a masking material, as it cannot be removed w/o damaging the threads.
Macropoxy 846	37 mins., 10 secs.	Preparation of the product took 31 mins. Dipped bolts into masking material to apply. Material was runny, like paint.	Yes	Received only 1 bolt back (the rest must have fallen out of the basket during the galvanizing process). A few very small areas did galvanize.	1 min., 11 secs.	Used a small metal-bristled brush to scrape away the product, which came off pretty easily.
Maskote Zinc Stop - Off	5 mins., 12 secs.	Very runny, hard to smear around. Rather than smearing, it dries, lumps up, and comes off the metal. Very strong, nauseating smell - similar to nail polish remover.	Yes	Some small areas did galvanize.	3 mins., 5 secs.	Used a small metal-bristled brush to scrape off the material, which came off very easily.
NAPA RTV Red	9 mins., 45 secs.	Smearred material on w/ a foam paint brush. Applied thick in many areas because of product consistency.	Yes	A few small areas picked up a little zinc.	4 mins., 18 secs.	Used a small metal-bristled brush to scrape away the material, which came off very easily.
Stop Galv	5 mins.	Dipped bolts into bottle to apply material. Thicker than Galva Stop. Hardened, but still flexible. Sticks to itself if it touches other coated products.	Yes	Got 5 bolts back. Almost all threads were completely bare.	10 mins., 20 secs.	Scraped the material off with a big metal-bristled brush. The material came off very easily and the threads had very little residue.
Valmont Masking Compound	9 mins., 10 secs.	Goes on very thick, so it could get expensive. Used a foam paint brush to spread around. Need an industrial size caulk gun.	-	All bolts lost during testing.	N/A	N/A
VHT Header Paint	N/A	Not tested, as paint cannot be easily removed after galvanizing.	-	N/A	N/A	N/A
ZYP Boron Nitride Hardcoat	4 mins., 5 secs.	Three mins. of application time due to stirring. Dipped bolts into material. Dries very fast.	-	Many areas had zinc frozen between the threads.	4 mins., 57 secs.	Used small metal-bristled brush to scrape material off. Baked-on material was much harder than other products. Could not remove all of the product.
ZYP Boron Nitride Lubricat	5 mins., 14 secs.	Three minutes of application time was stirring the product. Dipped bolts into masking material to apply.	-	All bolts picked up excessive zinc. A lot of the zinc was just frozen, but many areas galvanized too.	N/A	N/A

PHASE 2 TESTING - OVERVIEW

Product	Price	FLAT PLATE		BOLT THREADS		
		1 Hour Cure Time Success	2 Hour Cure Time Success	30 Min. Cure Time Success	1 Hour Cure Time Success	2 Hour Cure Time Success
DAP Household Adhesive Sealant	\$3.98 / 2.8 oz. tube	-	-	-	Yes	Yes
Galva Stop	\$48.00 / liter	Yes	Yes	Yes	Yes	Yes
GE 100% Silicone Caulk	\$4.97 / 10.1 oz. tube	-	-	-	-	Yes
Maskote Zinc Stop - Off	\$120.00 / gal.	-	-	-	Yes	Yes
NAPA RTV Red	\$14.19 / 11 oz. tube	-	-	Yes	Yes	Yes
Stop Galv	\$45.00 / qt.	Yes	Yes	-	Yes	Yes

PHASE 2 TESTING - OVERVIEW

Product	Price	Standardized Price	FLAT PLATE		BOLT THREADS		
			1 Hour Cure Time Success	2 Hour Cure Time Success	30 Min. Cure Time Success	1 Hour Cure Time Success	2 Hour Cure Time Success
DAP Household Adhesive Sealant	\$3.98 / 2.8 oz. tube	\$1.42 / oz	-	-	-	Yes	Yes
Galva Stop	\$48.00 / l.	\$1.42 / oz	Yes	Yes	Yes	Yes	Yes
GE 100% Silicone Caulk	\$4.97 / 10.1 oz. tube	\$0.49 / oz	-	-	-	-	Yes
Maskote Zinc Stop - Off	\$120.00 / gal.	\$0.94 / oz	-	-	-	Yes	Yes
NAPA RTV Red	\$14.19 / 11 oz. tube	\$1.29 / oz	-	-	Yes	Yes	Yes
Stop Galv	\$45.00 / qt.	\$1.41 / oz	Yes	Yes	-	Yes	Yes

BOLT THREADS - PHASE 2 TESTING						
Product	30 MINUTE CURE TIME		2 HOUR CURE TIME		2 HOUR CURE TIME	
	Success	Notes	Success	Notes	Success	Notes
DAP Household Adhesive Sealant	-	2 of the 5 bolts galvanized	Yes	Material was gummy and took a long time to remove.	Yes	Applied w/ a foam brush. One bolt out of the 5 had a little zinc on it. The material was very gummy and took longer to remove.
Galva Stop	Yes	One bolt had a tiny spec of zinc on it.	Yes	1 bolt galvanized a little less than 10%. Other bolts had miniscule amount of zinc.	Yes	Applied with a foam brush. Went on very thin. The outermost part of the threads looked like very little if any material went on those areas. The product still prevented galvanizing though.
GE 100% Silicone Caulk	-	3 of the 5 bolts galvanized	-	3 of the 5 bolts had zinc between the threads at the top 25% of the threads. Material was gummy and hard to remove.	Yes	Applied with a foam brush. One bolt out of the 5 had a little zinc on it.
Maskote Zinc Stop - Off	-	3 of the 5 bolts galvanized	Yes	The product scraped off the bolts very easily.	Yes	Applied with a foam brush. One bolt out of the 5 galvanized about 10-15%. This material dries extremely fast, which can make working with it hard. After applying masking material the outer edges of the threads appeared to be bare. It still masked the zinc effectively though.
NAPA RTV Red	Yes	None of the bolts galvanized, but the material was extremely sticky and was nearly impossible to get off the threads.	Yes	Material was very gummy and took a long time and considerable effort to remove.	Yes	Applied with a foam brush. Material was the gummiest out of the other materials and took the longest time to clean from the threads.
Stop Galv	-	All five of the bolts galvanized to some extent.	Yes	A few small specs of zinc here and there.	Yes	Applied w/ a foam brush. Went on slightly thicker than Galva Stop and seemed to cover surfaces better than Galva Stop too.

Appendix 2.
Pictures of Masking Materials During Phase 1 Testing

3M High Temperature Aluminum Tape



Protecting Steel for Generations

DAP Household Adhesive Sealant



Protecting Steel for Generations

Dow Corning Compound #111



Protecting Steel for Generations

Duct Tape



Protecting Steel for Generations

Galva Stop



Protecting Steel for Generations

GE 100% Silicone Caulk



Protecting Steel for Generations

Kapton Tape



Protecting Steel for Generations

Macropoxy 846



Protecting Steel for Generations

Maskote Zinc Stop-Off



Protecting Steel for Generations

NAPA RTV Red



Protecting Steel for Generations

Stop Galv



Protecting Steel for Generations

Valmont Masking Compound



Protecting Steel for Generations

VHT Header Paint



Protecting Steel for Generations

ZYP Boron Nitride Hardcoat



Protecting Steel for Generations

ZYP Boron Nitride Lubricoat



Protecting Steel for Generations

Additional Pictures



Protecting Steel for Generations