

SCREENED LEGEND QUALITY OF SIGNS  
FROM MICHIGAN STATE INDUSTRIES  
AND A REVIEW OF SCREENING MATERIALS



**TESTING AND RESEARCH DIVISION  
RESEARCH LABORATORY SECTION**

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M. H. Janson

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Hannes Meyers, Jr., Chairman; Carl V. Pellonpaa,  
Vice-Chairman; Weston E. Vivian, Rodger D. Young,  
Lawrence C. Patrick, Jr., William C. Marshall  
John P. Woodford, Director  
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## Background

As a result of problems associated with the handling and durability of signs with screened legends furnished by Michigan State Industries, representatives from the Maintenance and Testing and Research Divisions met with MSI representatives at the MDOT warehouse on March 17, 1980 to discuss these problems. During that meeting, finished signs with a black screened legend were examined and it was found that the ink could easily be removed by scratching either through routine handling or by a fingernail test. Those at the meeting considered it necessary to assess sign legend durability with an artificial weathering test and to obtain a mutually acceptable test for use in determining Department acceptance of signs prepared by MSI.

The laboratory determined that assessing legend durability by artificial weathering was too lengthy a test for practical use and that the test would not assess the more appropriate qualities of adhesion or abrasion resistance. In general, sign quality needed improvement since problems commonly associated with the screening and handling of screened signs were evident. It was decided that many of the problems could be alleviated by assembling and presenting review information on screening and screen process materials to those responsible for sign fabrication.

After the March 17 warehouse meeting, samples of signs judged to have good and poor quality legends were forwarded to the laboratory. Examination data were obtained as follows:

1) Sign with directional arrow legend (Lab. No. 80 RD-71) stamped 'MSI 1-76' on the back; the stamp identifies the cutting date of the aluminum blank. The sheeting was identified as 3M (engineering grade). Infrared analysis of the legend ink showed a similarity to an enamel such as NazDar 59-111. The legend film was 2.1 mils (0.0021 in.) thick and was very hard.

2) Sign with directional arrow legend (Lab. No. 80 RD-72) stamped on the back 'MSI 9-79.' The sheeting was identified as Seibulite. Infrared analysis of the legend ink tentatively identified the ink as NazDar enamel. It was understood that MSI had used a NazDar 59-111 opaque black enamel. The legend film was 0.8 mils (0.0008 in.) thick and scratched very easily. In order to assess what might happen during exposure after field installation, a portion of the sign was placed in the weatherometer. After 143 hours at the usual 105 F air temperature, the legend could not be scratched easily, indicating that the ink had cured completely. Another portion of the

sign was placed in a laboratory oven at 120 F for seven days. After this exposure the legend film had toughened considerably and had developed an acceptable scratch resistance, although in a few areas the ink tended to flake-off like a dried powder when scratched

It was noted that after scratching the legend ink from the sign surface, and especially in those areas where the ink flaked-off, no shadow was noticeable that would have indicated the ink had adhered to, or reacted with the sheeting surface. Many areas of the legend had an uneven legend outline and 'cob webbing' or static electricity streaks were noted just outside the legend outline. Generally, the legend edges contained a thick line or ridge of dried ink.

In response to our request for comparison test signs, six panels were screened at the Lansing Sign Shop using NazDar 59-111 black on Seibulite sheeting. The signs were delivered to the laboratory three days after legend application and given Lab. No. 80 RD-73. The legend film was 1 mil (0.001 in.) thick and scratched very easily. A small section of the sign was cured at 170 F for 24 hours which definitely hardened the film but the sheeting scorched. Another section from one of the signs was cured in a 120 F oven for seven days resulting in a noticeable improvement in scratch resistance or film hardness, but it was still possible to scratch the ink. An improvement in film hardness was also noted after the signs had been stored at room temperature for seven days. The dried film on these signs had an 'orange peel' appearance which might be expected on a very thick film. The appearance also may have resulted from using a large mesh screen (6XX was reported) and using an ink that would not 'flow out' immediately after screening.

After examining the signs it was determined that sign quality could be improved but recommendations for specific changes would be difficult because of variations in processing materials, equipment, and methods. The non-adhering, easily scratched legend on the sampled signs, for example, indicated that either the sheeting surface was contaminated or had not been cleaned prior to screening, that the ink was incompatible with the sheeting, that the ink was deficient in driers or had a drier imbalance, that the ink had been thinned excessively, or that the film was not properly dried or cured after screening. Investigation of these problems soon involved other considerations which led to a review of factors that affect sign quality. Information for the review was obtained from manufacturers of processing materials and reflective sheeting. Discussion of this information and product information includes a summary table showing characteristics of inks and screens.

## Thinners

Since screening ink formulations do contain various resins in varying quantities, thinners must be compatible with the ink formulation. In addition, the thinner must be suitable to the reflective sheeting surface and should not affect the color or transparency of the ink. It is important, therefore, to ensure use of the correct thinner by following manufacturers' recommendations or to obtain approval of alternates. Generally, thinning is unnecessary and the inks can be used as received. Excessive thinning can result in smeared legends or blurred edges on the legend and colors that are too light. Thinning should include thorough mixing followed by re-capping and standing for at least one hour before using.

In any discussion of thinners, it should be obvious that these materials are, or can be hazardous and, therefore, precautions against fire and health hazards become a part of screen processing production. Well ventilated areas are necessary for processing as well as storage. Forced air ventilation is recommended for storage areas such as the Lansing Sign Shop. Since the fumes are usually heavier than air, exhaust openings should be near the floor.

## Screening Inks

Selecting inks suitable for reflective sheeting can become critical if compatibility with the sheeting is not considered and if recommendations of the sheeting manufacturer are not solicited. Recommendations can be obtained from some sheeting manufacturers and recommendations can be prepared by this laboratory, but changes in ink formulations and changes in sheeting formulations can easily alter such recommendations. The sheeting manufacturer should be expected to maintain the most timely and responsive awareness to such changes. It is recommended, therefore, that processed signs either prepared or purchased by the Department be screened with inks either supplied or recommended by the sheeting manufacturer or screened with inks that are approved based on screened samples submitted for evaluation to the Department. It appears quite possible that the number of changes in inks and reflective sheeting materials occurring within the past few years have had an effect on screened sign quality.

Early in this investigation it was learned that a NazDar 59-111 black enamel had been in use for a number of years in our Lansing Sign Shop and by Michigan State Industries. MDOT Standard Specifications required NazDar 811 black. The 59-111 black is reported to dry more rapidly than the 811 black, but the 811 ink dries to a harder finish than the 59-111. That the inks were changed without notice is unfortunate but the changes probably facilitated screening operations by permitting a production volume increase.

Sign production continued using 3M sheeting and the signs apparently were satisfactory. Seibulite sheeting, manufactured by Mitsubishi International, replaced 3M sheeting and Mitsubishi apparently indicated that the 59-111 ink would give satisfactory results with their material. However, another change occurred in late 1979, when Mitsubishi International discontinued their 3000 series inks (3003 black) and began distributing a 3500 series (3503 black). It was claimed that MSI had been using the 3003 black but this could not be confirmed. Mitsubishi 3003 black is no longer available; therefore, its composition could not be determined, but it was assumed that the ink was a synthetic enamel. The 3503 black now recommended by Mitsubishi is a methacrylate based ink. It appears quite possible that Mitsubishi developed an ink that was more compatible with their sheeting than the NazDar 59-111.

### Screens

Screen materials such as dacron or polyester and nylon have been recommended by the various sheeting manufacturers. Monofilament screens have been recommended in the mesh sizes as noted in the table. Use of monofilament screens can be expected to eliminate the heavy ink deposit found along the legend edges of signs examined and also some of the 'tracking' in the background area. Frayed multifilament screens may have caused the discrepancies noted and maintaining clean screens or avoiding the build-up of dried inks might have alleviated the condition.

### Masking Films

Masking film or stencil film materials have become an important consideration because of ink formulation changes. Unfortunately, our Lansing Sign Shop has a large inventory of screens containing films that are soluble in lacquer thinners. These films can be ruined through the use of inks that cure during solvent evaporation. At this time, however, inks recommended by the sheeting manufacturer should be used and, therefore, sign shop screens will require replacement with water-soluble or lacquerproof stencils on monofilament screens.

Screens with water-soluble films are adversely affected by high humidity conditions and, therefore, a large inventory without a humidity controlled storage area should be avoided. A photographic process might be considered for the Department Shop to reduce screen inventories but more information is necessary and, therefore, a study of that process for Sign Shop implementation is recommended.

## Wash Solvents

Screen washing solvents or materials have been summarized in the Table. It should be noted that wash solvents can contain heavy oils which can be transferred to sign faces during subsequent screen operations and may result in an oil-spot rainbow of colors. The wash materials are the same as, or very similar to, the ink thinners, and, therefore, handling and storage condition recommendations are the same. It is recognized that the Department Shop has only one tank for washing screens and, therefore, further investigation could result in a single wash for all inks used.

## Screening

Inspection of the sampled sign faces showed the presence of air bubbles and uneven films which may have resulted from passing the squeegee too rapidly over the screen. Uneven edges, and tracking or 'cob webbing' at the edges, were noted. These defects may have resulted from too much pressure on the squeegee or loose screens or possibly too little 'off contact.' Excessive thinning and ink drying on the screen may have been responsible for streaks or uneven film thickness. It can be noted again, as an example, that Seibulite inks have been changed to permit more rapid processing but this was accomplished primarily by formulating an ink that dries more rapidly. Such inks will also dry more rapidly on the screen and, therefore, when printing intervals become greater than one or two minutes a flood pass must be used.

## Inks

Information on ink drying conditions, ink curing, and storage of signs has been discussed along with information on various manufacturers products. Some of this information has also been summarized in the Table. It should be noted that information on drying time of inks provides an estimated period of time required to obtain a 'dry to touch' condition. After initial drying, screened signs can be handled very carefully but the handling should be limited to that necessary to obtain final drying or curing. Final drying, usually associated with lacquer inks, often requires the use of forced air at elevated temperatures to facilitate solvent evaporation and formation of a hard film. Curing times usually are associated with enamels and are the time periods at elevated temperatures required to achieve a hard film by an oxidation reaction.

## NazDar Ink

As discussed above, the Sign Shops began using a NazDar 59-111 black enamel even though MDOT Standard Specifications require NazDar 811

black. The 59-111 black is reported to be less viscous, to dry more rapidly and be more flexible than 811 black, but the 811 ink dries to a harder finish than the 59-111. Both of the inks contain an alkyd resin, thus they cure by oxidation to form a hard film which should have a five to seven year service life on reflective sheeting. According to NazDar, their 59-111 ink is a synthetic enamel which will air dry in four to six hours and will cure in 30 minutes when exposed to a 180 F temperature. Manufacturers of Type 2 sheeting recommend 125 to 150 F cure temperatures which, therefore, results in curing the NazDar inks at 130 to 140 F for 120 minutes.

NazDar recommends their 59-000 mixing varnish to thin their inks. Use of their 52-135 clear coating varnish is recommended for maximum durability. The 59-000 series inks are compatible with any type of screen material and with either lacquer or water-soluble films. A NazDar 2555 screen wash or mineral spirits is recommended for cleaning the screens.

Manufacturers of Seibulite and Adcolite sheeting have indicated that the 59-111 ink gives satisfactory results with their material. However, inks supplied by Mitsubishi for Seibulite sheeting were changed in late 1979, when their 3000 series inks (3003 black) were discontinued and a 3500 series (3503 black) was distributed. It was assumed that the 59-000 series inks and the 3000 series were of similar composition and, therefore, NazDar 59-000 inks should not be used on Seibulite sheeting.

#### Mitsubishi Ink

Seibulite 3003 black is no longer available, therefore, its composition could not be determined, but it was assumed that the ink was a synthetic enamel. The 3503 black now recommended by Mitsubishi is a lacquer type ink and, therefore, relies on solvent evaporation to produce a hard finish film. Claimed life is seven to ten years with the signs still legible at end of life. A 15 to 20 minute 'dry to touch' is claimed with a final drying time of four to five hours at room temperature (70 to 75 F and 50 to 60 percent humidity). Forced drying at 155 to 160 F can be accomplished in 30 minutes. Drying at 130 to 140 F for 45 to 60 minutes is recommended for our sign fabrication.

Mitsubishi recommends their Seibulite 3511 thinner but their 3011 thinner is satisfactory. The T-900 or T-910 thinners from Advance Process Supply Co. are also recommended. A toner 3512 can be used for clear coating. The Seibulite 3500 series inks are not compatible with their 3000 series inks and the 3500 series inks will destroy lacquer soluble films on screens. A water-soluble or lacquerproof film is necessary for masking screens. Mitsubishi recommends a 16XX or 180-200 mesh monofilament

screen. The 180 mesh screen should be expected to produce a 0.3 mil (0.0003 in.) dried film according to Mitsubishi. Screens can be washed with a substitute xylol—a solvent developed to conform with air pollution rules in some states—xylol, or a mixture of 25 percent xylol, 25 percent methylethyl ketone (MEK) and 50 percent deodorized kerosine. Experience may show that the MEK can be partially or completely replaced with the kerosine.

Recent analytical evidence indicates that MSI has changed inks and is using Seibulite 3500 series inks. On May 28 a shipment of 'No Passing Zone' signs from MSI were sampled at the warehouse. The screened legend could not be scratched with a 2H pencil as prescribed in ASTM D3363. Infrared analysis identified the ink as an acrylic lacquer such as 3503.

Signs fabricated with Seibulite sheeting should be handled carefully and it is recommended that through critical observation, handling procedures be reviewed to promote care in sign moving or handling phases such as storage before shipment, preparation for shipment, shipment, receiving, warehousing, and then again during shipment to the job site, and final sign erection. Before storing finished signs it is very important that the final color or clear coating be completely dry. High humidity conditions and cool temperatures will extend dry times. Signs may be stored flat on individual racks or, if stored on edge, may be stacked with each face covered by slip sheets or adhesive liner sheets, waxy side next to the finished face. It should be noted, however, that incomplete signs, or signs that will be screened with additional legend, such as state route markers, should not be covered with liner sheets or liner films. Only the 3M Co. SCW 82 slip sheeting should be used for such signs.

Signs must be kept dry until erected. Prior to packaging, each sign face must be protected by slip sheets or adhesive liner sheets. Cardboard or similar materials may be used as a sign packaging material for shipment. Package banding which results in the signs being under pressure is unsatisfactory. Signs should be shipped with packages on edge and handled on edge until erection. At the warehouse, or in other storage facilities, signs should be handled on edge and with the faces protected by liner film, liner paper, or slip sheets as appropriate. Contact between finished faces should never occur and contact of a finished face with the back of a panel should be avoided.

Small signs in opened or broken lot packages, or individual signs when transported in open bed trucks, should be covered or preferably placed in individual sign racks with slip sheets removed. Transport in this manner should prevent accidental loss of the slip sheets. Large sign faces should

remain covered for protection until the sign is bolted in place. Adhesive tapes that may be necessary to hold protective papers should not contact the sign face.

### 3M Inks

The 3M Co. will not recommend screening inks other than their own for use on 3M sheeting materials. They also caution that application of their ink to other grades or types of sheeting may result in premature failure of the sheeting. Accordingly, 3M's 700 series inks (705 black) are for exclusive use on their engineering grade sheeting.

The 700 series inks are enamels and, therefore, rely on curing through oxidation to obtain a finish film. A life of five to seven years is claimed for the inks. Drying in air requires 24 hours and use of high volume fans is recommended. Oven curing can be accomplished at a maximum temperature of 175 F in two hours but an initial half-hour air dry period is recommended. A five-hour drying at 130 to 150 F after the initial half-hour air dry is recommended for our sign fabrication. 3M recommends their Scotch-lite 711 thinner, a reported slow evaporating thinner, which can be added up to 25 percent by volume. Clear coating is not recommended and according to 3M, use of a clear coat will shorten sign life.

Polyester screens with a 157 mesh or 10XX equivalent should be used and the screens can be masked with either water-soluble or lacquer soluble films. The Scotchlite 711 thinner, mineral spirits, or xylol are recommended to wash screens. 3M also recommends that their 700 series inks be stored in a cool place and that the inks be used within one year.

Finished 3M engineering grade signs should be handled as described for Seibulite signs.

Even though 3M is the only manufacturer of MDOT Type 3 sheeting (High-Intensity) a review of inks used for that sheeting is included. 3M's series 800 inks (805 black) are used exclusively for sheeting with a heat-activated adhesive but only on the unapplied sheeting. A durability of 10 years is claimed for the inks but only three years is claimed for black when screened on orange. Processing of unapplied sheeting requiring use of series 800 inks is not anticipated at either the MSI or the Department's sign shops and, therefore, further details are unnecessary.

3M's series 840 inks (845 black) are used exclusively for applied sheeting but only the 845 black is recommended for use on heat-activated adhesive sheeting. Durability is not known but the three year life of black on

orange should be expected. It should be noted that Type 3 sheeting signs are too large for screen processing and cannot presently be processed with a legend material having a life equivalent to the claimed life of the sheeting. For example, yellow panels with 'Exit Only' legends have been processed by hand application of thinned black ink or with Scotchcal non-reflective film. Neither process is satisfactory and the alternate black screening of Type 3 sheeting which can then be cut out to form the legend appears very costly. A long life substitute for the Scotchcal is under investigation in the laboratory and will be reported later.

When thinning is necessary, Scotchlite 841 thinner is recommended to be used sparingly as a replacement for solvent evaporation losses. Scotchlite thinner 811 should not be used. A minimum of 24 hours air drying is necessary with an air flow from high volume fans through processed faces spaced 2 in. apart. Bubbling of the screened ink can be alleviated by reducing—but not stopping—the air flow for no more than 20 minutes. Oven drying can be accomplished with adequate air flow at 105 to 135 F for two hours but an initial air dry for 30 minutes using high volume fans is recommended to allow the ink to 'flow out.'

Clear coating is recommended for all 840 series transparent colors and is necessary to obtain claimed life. Presence of the coating can be detected by very lightly scraping the finished surface with a sharp blade and noting gray shavings (top coat) or colored shavings (no top coat). The 845 black should not be clear coated.

Polyester screens with a 157 mesh or 10XX equivalent should be used. Screen equivalents to the 157 mesh can range from 10XX to 16XX but according to 3M, a 10XX screen or 157 mesh are necessary, particularly on stop signs, to obtain correct color. The screens should be masked with a water-soluble film. Lacquer soluble films can be used but washing with mineral spirits would take longer than washing with stronger solvents which will dissolve the ink more readily. Scotchlite 841 or xylol are recommended for washing the screens.

With some exception, High-Intensity grade sheeting signs should be handled as described for Seibulite signs. Stacked sign faces must be protected by 3M's SCW 82 slipsheeting, plastic side toward the sign face. The polyethylene liner film should not be used. Before packaging a 1/8-in. foam pad should be placed between the slip sheeting. Experience may show that the pad can be eliminated. It is important to avoid subjecting the sign faces to stacking or packaging pressures. Presently, it appears absolutely essential that finished signs be kept in a dry interior location. Signs that accidentally become wet should be removed from any packaging padding or slip sheeting immediately and allowed to dry.

### American Decal Ink

American decal can supply inks for their sheeting but it was understood that NazDar 59-000 series inks and 3M series 700 inks are compatible with Adcolite sheeting.

### Other Sources

Transparent and opaque silk screening inks for reflective sheeting are available from sources other than those mentioned above, such as, Advance Process Supply Co., Kansas City Silk Screen Co., et al. However, since inks from these or other sources not mentioned above have not been evaluated, we recommend that at this time, the recommendations in the next section be followed.

### Summary of Materials Compatibility

- 1) Seibulite sheeting - use only Seibulite series 3500 inks,
- 2) 3M engineering grade sheeting - use only 3M series 700 inks,
- 3) Adcolite sheeting - use NazDar series 59-000 or 3M series 700 inks,
- 4) 3M High-Intensity unapplied sheeting with heat-activated adhesive - use only 3M series 800 inks, except that 845 black may be used,  
3M High-Intensity applied sheeting with pressure sensitive adhesive - use only 3M series 840 inks.

The above recommendations are not consistent with MDOT Standard Specification 8.26.02-d-5, 'Sign Legend Material, Paint.' The specification requirements are obsolete. A revised 8.26.02-d-5 is recommended as follows:

5. Paint. Where a black legend is required it shall be applied by the silk screen method. The paint used shall be as recommended by the reflective sheeting manufacturer. Applied legend shall not be removed when tested by both the Film Adhesion Test and the Film Hardness Test.

Since some black legend signs are too large to be processed by silk screening it is also recommended that 8.26.02-d-1 be revised to include a final statement in the first paragraph as follows:

Non-reflective black sheeting materials for letters, numerals, symbols and borders shall be as specified on the plans.

### Test Procedures

Artificial weathering to determine suitability of warehoused signs for field installation is too lengthy a test for practical use, but an ASTM test for film adhesion and a test for film hardness were found.

ASTM D3359, "Standard Method for Measuring Adhesion by Tape Test" describes two methods, both destructive. One of the methods is currently paraphrased in 8.26.02 c 13 of the Standard Specifications. Satisfactory results from either method of test would indicate compliance with specification requirements. The test could be conducted in the sign shops shortly after the screened film normally would be expected to be dry.

ASTM D3363, "Standard Test Method for Film Hardness by Pencil Test" is considered a non-destructive test and could be used at any time but probably more appropriately for acceptance test comparisons upon delivery at the warehouse. Samples of Seibulite reflective sheeting screened by NazDar and with NazDar 59-111 black were just noticeably scratched by a 2H (Eberhard Faber) pencil. A softer F (Eberhard Faber) pencil would not scratch the film.

Fifty-two signs selected randomly from the finished sign inventory at the warehouse were subjected to the film hardness test. Approximately 50 percent of the signs failed or had screened legend films that were easily scratched with an F pencil. Of the other 50 percent, half could be scratched with a 2H pencil, and the other half could not.

Those signs failing the F pencil film hardness test will be especially susceptible to abrasion effects during handling and after sign placement. Since hundreds of signs are involved, handling and shipping of all signs should include protecting the sign faces at all times as described and holding the signs on edge until installation.

It is recommended that Section 8.26.02 c 13, second paragraph, be revised to read:

Process inks shall not be removed when tested by both the Film Adhesion Test and the Film Hardness Test.

The Film Adhesion Test and the Film Hardness Test are recommended for addition to Michigan Test Method MTM 702 as follows:

- j. Film Adhesion Test. Screened films conditioned at least 24 hours after application shall be tested in accordance with either method A or B as described in ASTM D3359. Satisfactory adhesion will be determined by a rating of 4A or better when tested by Method A or by a classification of 4 or better when tested by Method B.
  
- k. Film Hardness Test. Screened films conditioned at least 24 hours after application shall be tested in accordance with ASTM D3363, Film Hardness by Pencil Test. Satisfactory hardness will be determined by a 2H pencil for gouge hardness and an F pencil for scratch hardness.

It is recommended that MSI adopt the film hardness tests as part of their quality control procedure.

## INK AND SCREEN CHARACTERISTICS

Materials Characteristics	Manufacturer			
	NazDar Co.	Mitsubishi Corp.	3M Co.	3M Co.
Series Identification	59-000	3500 <sup>1</sup>	700	840 <sup>2</sup>
Color: black, opaque	59-111	3503	705	845
red, transparent	59-109	3515	712	842
green, transparent	59-149	3508	708	848
blue, transparent	59-159	3506	710	843
Resin base	alkyd enamel	methacrylate lacquer	alkyd enamel	methacrylate lacquer
Sheeting compatibility	Adcolite	Seibulite	Scotchlite engr. grade Adcolite	only applied Scotchlite High-Intensity grade
Drying conditions and time:				
Air	4-6 hr	10-15 min 'to touch.' 4-5 hr, 70-75 F at 50-60% humidity	24 hr with high volume fans	24 hr on racks with 2-in. air space and high volume fans
Oven		30 min, 155-160 F 60 min, 130-140 F recommended (option to air dry)		2 hr, 105-135 F (option to air dry)
Curing conditions	cures by oxidation 30 min, 180 F 2 hr, 130-140 F recommended	cures by solvent evaporation	cures by oxidation after initial 30 min air dry at room temp., 2 hr, 175 F; 4 hr, 130-150 F recommended	cures by solvent evaporation
Film life, years	5-7	7-10	5-7	10, except 3 for orange
Shelf life, years	1	1	1	1
Storage conditions	well ventilated cool area	well ventilated cool area	well ventilated cool area	well ventilated cool area
Thinner	59-000 mixing varnish	3511 or 3011 or Advance Process Supply Co. T-900 or T-910	711	841
Cover coat	52-135, not necessary on black	3512	not recommended	840, not necessary on black
Material	any material, monofilament	polyester, monofilament	polyester	polyester
Mesh	12XX - 16XX	16XX, 200 mesh	10XX, 157 mesh	10XX, 157 mesh
Masking film	lacquer or water soluble	water soluble	lacquer or water soluble	water soluble
Wash solvent	2555 or mineral spirits	substitute xylene, xylene, or mixture of 25% xylene, 25% MEK, 50% kerosene	Scotchlite 711 or mineral spirits, or xylol	841 or mineral spirits or xylol

<sup>1</sup> Series 3500 inks should not be mixed with series 3000 inks.

<sup>2</sup> 3M Series 800 inks are available for use only on unapplied Scotchlite High-Intensity sheeting.