Instruction Bulletin 3.19
Release A, August 2001

Screen Printing

3M™ Scotchlite™ Four Color Screen Printing Ink Series 2900

Product Replacement Note

3M™ Scotchlite™ Transparent Screen Printing Ink Series 2900 replaces 3M™ Scotchlite™ Screen Printing Ink Series 4400, both line color and four color.

Do not mix ink series 2900 and 4400 together; these inks do not adhere well to one another.

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What Is Four Color Screen Printing?

Four color screen printing is the reproduction of a full color original subject as a halftone. The three primary colors-yellow, magenta, and cyan-plus black are printed sequentially in close register to form the image.

The processing of four color screen printed graphics requires careful preparation and execution. Be aware that the pigments in 3M™ Scotchlite™ Four Color Screen Printing Ink Series 2900 may be slightly different than those in other 3M four color screen printing inks. Adjustments may need to be made in the color separations when switching from one ink to another.

Applications and Uses

Four color ink series 2900 are high performance inks formulated for use on selected 3M™ Scotchlite™ Reflective Graphic Films. When used according to 3M recommendations, these inks allow the reflective properties of the graphic films to be seen, except when using black.

Four Color Transparent Concentrates	
Halftone Concentrates	**Halftone Bases**
2986 Yellow 2984 Magenta 2987 Black[2] 2985 Cyan	2988 Standard 2989 Retarder
Overprint Clear	
2920DR Dirt Resistant Overprint Clear 4430R Petroleum Resistant Overprint Clear 9720 UV General Purpose Overprint Clear with UV protection	
3M™ Thinners	
For concentrates	**For clears**
CGS-30 CGS-50 CGS-80 [1]	CGS-30 CGS-50

[1] The higher the CGS number, the slower the evaporation rate.

[2] Black ink is opaque, not translucent.

Compatible Products

Note: For films not listed here, check the film's Product Bulletin for compatibility with ink series 2900.

Films

- 3M™ Scotchlite™ Removable Graphic with Comply™ Performance Film Series 680CR and 680CR CM-10[1,2]
- 3M™ Scotchlite™ Changeable Graphic Film 5100
- 3M™ Scotchlite™ Reflective Graphic Films
  - Film 550-10U
  - Series 580 and Film 580-10U
  - Series 680 and Films 680-10U and 680CM-10U[1]

[1] Color-matched reflective films

[2] Film 480, 681 and series 690 have been replaced by 680CR.

Other

In general, ink series 2900 can be used as an alternative to any application that recommends 3M™ Screen Printing Ink Series 4400.

Note: For the full product names of the 3M products listed on this page, please see page 1.

Note: All Product and Instruction Bulletins mentioned in this bulletin can be ordered through our Fax-on-Demand system. See Related 3M Literature near the end of this bulletin for details.

Health and Safety

⚠ Caution

Provide adequate ventilation and observe safe operating procedures when using ink series 2900. Refer to the Material Safety Data Sheets (MSDS) for details.

⚠ Caution

When handling any chemical products, read the manufacturers' container labels and the Material Safety Data Sheets (MSDS) for important health, safety and environmental information.

To obtain MSDS sheets for 3M products:

- By fax, call 1-800-364-0768 in the US and Canada or 1-650-556-8417 for all other locations.
- Electronically, visit us at www.3M.com/MSDS.
- By mail, or in case of an emergency, call 1-800-364-3577 or 1-651-737-6501.

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

Stock Preparation

Sheet Conditioning

You may need to condition the sheets of film before using them for a job that has tight tolerances or multiple colors. A change in the humidity or the temperature can affect the moisture content of the liner during storage and/or printing. These changes can affect registration and lay-flat characteristics.

For the best results, follow these guidelines:

All Liners

- Keep the sheets of film wrapped in polyethylene.
- Complete the printing as quickly as possible.
- Avoid stacking the sheets of film in an uncontrolled environment. The stacked sheets absorb moisture unevenly and may develop wavy edges.

Kraft Paper Liner Only

- Stabilize the sheets of film under the normal humidity and temperature conditions of the shop.
- Condition the sheets of film overnight by racking them individually or two sheets face-to-face.

Sheet Cutting

The sheet size and the direction the sheet is cut from the roll can affect the liner stability to humidity and temperature variations.

For the best results, follow these guidelines:

- Print a fewer number of graphics on a smaller sheet size instead of printing more graphics on a larger sheet.
- If possible, cut all sheets in the same direction and put the critical length parallel to the roll edge.

Pre-drying Sheets

Some screen printers find it helpful to run the unprinted sheets through the conveyor dryer once immediately before printing.

Special Considerations for Reflective Films

Reflective film will not properly retroreflect in the printed area if you use an opaque ink or a formulation containing opaque ink.

It is difficult to closely match colors of multi-sheet graphics on retroreflective film. This is because production lots may vary. Always check adjoining panels of reflective film for both daytime and nighttime appearance.

Follow the recommendations in Instruction Bulletin 2.1 to minimize within-lot and cross-web variation. Reflective films 680CR CM-10 and 680CM-10U are available already color matched.

Ink and Overprint Clear Preparation

⚠ Caution

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

⚠ Caution

Before handing any chemical products, always read the container label and the MSDS.

Inks and overprint clears from ink series 2900 must be reduced to reach the desired viscosity.

Many factors affect the ink coverage, including:

- Screen mesh and type.
- Average halftone dot density.
- Amount of thinner.
- Hardness (durometer) and angle of the squeegee.

Note: For the full product names of the 3M products listed on this page, please see page 1.

Coverage for Four Color Screen Printing Inks

Under typical conditions with press-ready ink and using a 280 tpi (threads per inch) mesh screen, the approximate coverage is:

- 100% (solid) printing: one gallon (3.8 liters) covers 1800 square feet (44 m^2).
- 50% dot coverage: one gallon (3.8 liters) covers 3600 square feet (88.2 m^2).

Mixing Inks

- The four color inks in ink series 2900 are supplied as concentrates. The recommended formula by weight is 20% ink concentrate, 70% halftone base and 10% thinner formula.
- Up to 10% of CGS-30, CGS-50 or CGS-80 may be added to reduce the viscosity (the higher the number, the slower the evaporation rate).
- Printing large open areas or very small halftone dots with long mesh open times may require a higher proportion of retarder halftone base 2989 and/or thinner CGS-80. Use caution when making these adjustments as slow drying problems may result as the system is retarded. A shift toward higher proportions of halftone base 2988 increases the drying speed but may lead to drying in the screen.

Thinning and Coverage for Overprint Clear

Overprint clear 2920DR typically needs 20 to 30% thinner added to reach the desired viscosity of 600 to 900 Centipoise. Using a 200 tpi mesh screen, the approximate coverage is one gallon (3.8 liters) covers 2500 square feet (61.4 m^2).

To thin overprint clear:

- Use thinner CGS-30 or CGS-50.
- Start by adding one part thinner to 5 parts clear *by volume*.
- The recommended viscosity is 600 to 900 centipoise (approximately 30 seconds in a #5 Zahn cup).

To obtain the stated durability printed and cleared film, the thickness of the overprint clear after drying must be a minimum of 0.00024 inches (0.006 mm) on the printed areas. Usually this thickness can be obtained only for one of the following methods:

- Screening the overprint clear through a screen of 200 tpi or coarser.
- Roll coating, thinning the clear no more than 30% by weight.

It is assumed that sufficient clear has been applied if shop documents verify the overprint clear usage (discounting waste) of at least one gallon overprint clear, unthinned, for each 2500 square feet coated (3.8 liter per 61.4 m^2).

Other Considerations for Mixing Inks and Overprint Clears

- Properly prepared halftone ink has a texture similar to warm butter. Because these inks are thixotropic, they become more liquid when stirred. Upon standing they return to a more viscous or "warm butter" texture.
- Mix the ink and the overprint clear for 10 minutes before formulating the colors or printing. This ensures an even distribution of all ink components.
- If you add components to adjust the density or printability, mix for an additional 5 minutes.
- Use a high-speed power mixer with a blade 1/3 to 1/2 the diameter of the container. If the blade is smaller than this, move it around in the container. Put the blade 2/3 of the way into the liquid.
- Always mix enough ink for the entire job in one batch. Even the most careful weighing and mixing usually does not produce two lots of the same color that print at the same density. Density shifts affect the gray balance.
- Except as specified in this instruction bulletin, we do not recommend or warrant the following:
  - Printing four color ink series 2900 at reduced strengths.
  - Using color formulations for line copy.
  - Modifying color hue.

Ink Adjustment

When first mixed or as a result of the first screen impressions, it may be necessary to adjust the printing density or printability of the ink. Because accurate density adjustment requires the use of a densitometer or a visual standard, adjustment methods are explained later in the section on color control. All ink adjustments should be kept as small as possible and should be recorded for future reference.

Note: For the full product names of the 3M products listed on this page, please see page 1.

Color Control Tools

Producing a large quantity of multi-sheet, four color graphics requires a high degree of color control. If visual judgment of color and density are not satisfactory, the following quality control tools are essential for a high yield of quality graphics.

1. A satisfactory proof or acceptable color progressive of the same graphic retained from a previous printing with the same inks. In either case, the color bars must be present for solid tone and half tone measurements.
2. A reflection densitometer equipped with color filters identified as "separation" or "graphic arts" filters (narrow band). Color filters identified as Status A, M, T or SPI are not acceptable.

Color Density Targets

A measurement of the color density of the first color-bar of the proof serves as the target density for printing the first color. This measurement can be made on either of the items in Step 1 above. If either of these is not available, the density that one obtains for a graphic will depend on the model of densitometer used and its condition from length of use, age of bulb in densitometer, age and condition of filters, and so on. Density readings should not be quoted and transferred from one densitometer to another. Printed color bars, either litho or screen printed, should be used for reference.

The following table provides examples of some densities of the YMCK that one might obtain.

Color	Suggested Target Density
Yellow (Y)	1.00
Magenta (M)	1.30
Cyan (C)	1.30
Black (K)	1.50

Note: Prior to measuring the densities of the proof, make sure the densitometer has been zeroed to the white of the substrate before measuring the densities of the printed 3M™ Screen Printing Ink Series 2900.

Color Control

First Color

Once good screening conditions have been established, the density of a color bar should be measured and compared to the target value. If this density differs from the target by more than 0.03 the inks will need to be adjusted. For other than mechanical adjustments, refer to the following table for guidance.

Other Colors

The commitment to a density for the first color establishes the density targets for the subsequent colors. Each of the original target densities should be adjusted by an amount equal to the difference between the first color and its target.

The following table provides an example of the difference between original and new target densities when using multiple colors.

Color	Target	Actual	Difference	New Target
Yellow	1.00	0.91	-0.09	
Magenta	1.30		-0.09	1.21
Cyan	1.30		-0.09	1.21
Black	1.50		-0.09	1.41

Every attempt should be made to screen to densities within 0.05 of these targets.

As printing progresses, the densities of the color bars and selected areas of halftone dots should be monitored. Any change in the densities indicates a potential problem that should be addressed before a density drifts out of an acceptable range.

Ink Adjustment - Density

If it is necessary to increase or decrease the printing density of the ink as originally mixed, the following table may be used to estimate the quantities of ink concentrate or halftone base and thinner which must be added to effect the desired result.

Desired Density Change	Percentage of Original to Add
0.05	12%
0.10	26%
0.15	41%
0.20	58%
0.25	78%
0.30	100%

Thus, to increase the density by 0.15, add 41% of the original weight of ink concentrate. To decrease a density by 0.10, add 26% of the original weight of halftone base and thinner.

Note: If the ink has been reclaimed from the screen, original weights must be reduced based on the reclaimed weight before the additions are calculated.

Note: For the full product names of the 3M products listed on this page, please see page 1.

Screen Printing

⚠ Caution

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⚠ Caution

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The printing order of the colors is not critical but should be the same as the order used in proofing.

The following procedures and recommendations assume the availability of a satisfactory halftone positive. If guidance is needed in obtaining a satisfactory positive, refer to Instruction Bulletin 1.1.

Frame

- Use rigid screen frames that are large enough to provide at least a 6 to 10 inch (15 to 25 cm) well between the frame and the open stencil area.
- The recommended screen tension is 20 Newtons/cm or higher.

Fabric

Tightly and uniformly stretch a monofilament thread, twill or plain weave fabric on the frame. Using a plain weave or calendared fabric may reduce the color intensity and opacity.

- Four color inks: use a 280 tpi screen fabric (112 t/cm).
- Overprint clear: use a 200 tpi screen fabric (80 t/cm).

Stencil

- Use a photographic or hand-cut stencil that is water soluble and resistant to ketones and strong lacquer solvents.
- Prepare all four stencils for a graphic before printing begins.

Squeegee

- Use a sharp squeegee with a medium to hard, rubber or plastic blade. The squeegee should be large enough to overlap the design by at least 2 inches (5 cm) on each side.

Screen Exposure

- Expose screens in a vacuum frame with the exposure lamp separated from the screen plane by a distance greater than the diagonal dimension of the area to be exposed.
- Monitor each exposure by including a transparent gray scale and controlling it with an exposure integrator.
- Maintain tight, uniform contact between the halftone positive and the stencil throughout the exposure. Poor contact in any area will cause a loss of dot percentage.
- If the final positive does not include the image of color bars, they should be added. A piece of opaque tape in the trim area of the positive creates an opening in the screen which will print a solid color.

Printing Method

1. Remove any dust or particles from the fabric, the stencil and the film sheets by using a tack rag (a varnish-impregnated cloth). Cleanliness and controlling dust are important to getting good results.
2. Position the film on the press bed.
3. Hold the film in place with a vacuum.
4. Use the off-contact screen printing method to produce a uniform impression. Make a fill pass and then make the impression pass.

Screen Cleaning

See **Clean Up** on page 6.

Note: For the full product names of the 3M products listed on this page, please see page 1.

Drying Inks and Clears

Listed below are suggestions for obtaining properly dried graphics. Times and temperatures vary with equipment, amount and type of thinner or retarder, ambient temperature, humidity and air flow. Insufficient drying can result in blocking or severe surface impressions.

It is essential that sufficient residual thinner be removed from the graphic before the premask tape is applied. If there is any question as to sufficient dryness, a dryness test should be performed.

Drying Method	Minimum Temperature	Minimum Time
Air	Ambient	24 hours
Batch	150°F (64°C)	10 minutes
Conveyor[1]	150°F (64°C)	30 seconds

[1] Conveyor drying is recommended. Check the conveyor temperature at various locations across the belt.

Dryness Test

To ensure dryness, test the graphics as follows:

1. This test is designed to set the dryer conditions and approximate dryness.
   a. Touch a printed sheet, face to face.
   b. Place the touched area close to your ear and separate the film.
   c. If the graphic is adequately dried, there will be either a slight sound or no discernible sound when the surfaces are separated. If the graphics are not dried, there will be a crackling sound. The louder the sound, the greater the amount of additional drying that is required.
2. This test is designed to definitely determine if adequate drying has occurred.
   a. Place several printed, dried sheets, face to face, under a 12 inch (30 cm) stack of film. A weight of 2 pounds/square inch (135 gm/cm^2) can be used in place of the film stack.
   b. After 10 minutes, remove the sheets and check for blocking or surface impressions.
   c. If blocking or severe surface impressions are noted, additional drying is required. The temperature may be increased or the conveyor speed may be reduced.

Registration

Maintaining good registration is critical to good visual color balance. The single most important factor affecting the ability to maintain registration is drying temperature. It is important to the entire process that drying temperatures be only as high as is absolutely necessary.

Clean-up

⚠ Caution

Before handing any chemical products, always read the container label and the MSDS.

Screen and Equipment Cleaning

Use a commercially-available lacquer thinner, thinners CGS-50, CGS-80 or a blend of solvents such as xylol, methyl ethyl ketone and/or methyl isobutyl ketone, and VM&P naphtha. Less aggressive solvents may not clean the screen thoroughly and may adversely affect the print quality of the screen when it is reused.

Non-solvent screen washes must be tested. Some brands may cause the ink to gel in the screen or the reclaimed ink can contaminate unused ink.

Cleaning Off Overprint Clear

To clean off overprint clear from the screen, use thinner CGS-30 or CGS-50 or a similar solvent.

Important Note!

The inks and overprint clears from ink series 2900 are not compatible with some solvents commonly used for screen washing and clean-up. All such solvents should be tested before use. The use of incompatible thinner will produce a gummy residue, which will be very difficult to remove.

Application Tapes

After the graphics are thoroughly dry you should apply a prespacing tape or premasking tape using a roll applicator. Do not use heat. See the film's Product Bulletin and Instruction Bulletin 4.3 for details on selecting and using application tape.

Shelf Life, Storage and Shipping

Ink Series 2900

- Store the inks at 32° to 90°F (0° to 32°C).
- Use the ink within 1 year of purchase.
- Store the inks in the original container or in other sealed polyethylene containers. Do not store the inks in glass containers.
- Store and use inks in dry areas away from direct sunlight.

Finished Graphic

- Be sure the ink and the overprint clear are cured before packaging the finished graphic.
- Ship the finished graphic lying flat or rolled. To roll, wrap the graphic film-side out onto a core that is 5 inches (13 cm) or larger in diameter. These methods help to prevent the film and premask from wrinkling or popping off the liner.
- Put a slip sheet, such as 3M™ Easy Release Liner SCW-33, on the printed side of the following types of graphics:
  - a graphic that is pre-mounted on panels.
  - panels that have graphics on both sides.
  - a liner that is printed by the printer.
- Store the graphics in a clean, dry area.
- Store the graphics out of the direct sunlight and at a temperature less than 100°F (38°C).
- See Instruction Bulletin 6.5 for details.

Warranty and Limited Remedy

This bulletin describes a technique. The information contained herein is believed to be reliable, but 3M makes no warranties, express or implied, including but not limited to any implied warranty of merchantability or fitness for a particular purpose. To the extent allowed by law, 3M shall not be liable for any loss or damages, whether direct, indirect, special, incidental or consequential, in any way related to the technique of making a graphic regardless of the legal theory asserted.

3M Related Literature

Listed below is related 3M technical literature that may be of interest. You may view and print these Bulletins from our website at www.scotchprint.com, or order them via our Fax-on-Demand (FOD) system. Call one of these phone numbers to order the desired bulletins, and specify the FOD document number provided in the chart.

United States or Canada: 1-800-364-0768
International: 1-651-732-6506

Subject	Bulletin No.	FOD No.
Product Bulletins		
Films and sheetings Order an index from the Fax-on-Demand system to identify the FOD No. for the film or sheeting bulletins you need.		
3M™ Scotchlite™ Screen Printing Ink Series 2900		
Instruction Bulletins		
Preparation for four color screen printing	1.1	5001
Design of graphics	2.1	5501
Screen printing with line ink series 2900	3.18	6018
Scoring and cutting	4.1	6501
Using 3M application tapes; premasking and prespacing for films	4.3	6503
Storage, handling, maintenance, removal	6.5	8505
Warranties		
Worldwide 3M™ MCS™ Warranty Packet *(includes all Commercial Graphics MCS Warranties)*		9503
Worldwide 3M™ MCS™ Warranty Overview-Folder		9504
3M™ MCS™ Graphics Warranty for Fleet Vehicle Applications *(includes overview)*		9506

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Health & Safety

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

Important Notice to Purchaser

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

3M's warranty provides that if 3M finds that goods are defective in material or workmanship they will be replaced or the price refunded at 3M's option but note that 3M does not accept liability for other direct losses (except for personal injury or death) or consequential losses relating to defective products or from information supplied by 3M.

Purchasers and users of 3M products, and not 3M supplying companies, are always solely responsible for deciding on the suitability of the 3M product for their required or intended use.

Technical Assistance

For help on specific questions relating to 3M Commercial Graphics Division Products, contact your local Technical Service Representative.

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