



*National Association
of Graphic and Product Identification
Manufacturers, Inc.*



INDUSTRY STANDARDS AND PRACTICES



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The information contained in this publication is not meant to be all-encompassing, but rather to draw attention to the particular subjects covered. All suggestions and recommendations contained in this Standards and Practices Manual are based upon information that is believed to be accurate to the best of the participating members' knowledge and their collective experience at the time of publication, but are made without guarantee or representation as to results. GPI expressly disclaims any warranties or guaranties, express or implied, and shall not be liable for damages of any kind in connection with the material, methods, information, techniques, opinions or procedures expressed, presented, or illustrated.

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INTRODUCTION

The National Association of Graphic and Product Identification Manufacturers (GPI), established in 1951, encourages advancement in the technical arts of the graphic and product identification industry, while promoting the interests of our membership. At GPI, we accomplish our mission and share information by hosting general meetings, sponsoring educational seminars, developing standards, and other appropriate and legal means determined by the Board of Directors.

Believing in the unity and strength gained from a cooperative approach to industry challenges, GPI continues to expand member services as our Association grows. This Standards and Practices Manual, first published in 1969 and revised in 1975, 1987, 1994 and, 2009, reflects GPI's commitment to member services. This latest revision contains up-to-date information, including sections on the digital technologies that continue to change our industry.

Most products require some type of decoration, identification, or instruction. The design and manufacture of these engineered graphics and product identification products employs a wide variety of materials, processes, and equipment. This document will assist those who design, purchase, inspect, or use graphic and product identification to make informed decisions when considering these options.

In recent years, the graphics and product identification industry has met the increasingly specialized needs of our customers by using significantly improved technologies and equipment as well as more varied materials and surface finishes. The industry has also responded to new environmental responsibilities. Some manufacturers may produce a wide variety of the products found in this manual, while others may focus on a particular niche market. Since this document is intended as a general guide for users, we suggest that specific questions be directed to individual manufacturers and their suppliers.

This manual uses generic names for most materials used in manufacturing, or refers to performance specifications, rather than trade names. This permits the manufacturer, in conjunction with designers and engineers, to select the brands of materials that provide the best combination of price, availability, and processing characteristics while meeting the customer's quality and performance requirements.

Members of GPI with expertise in various industry specialties prepared the information in this manual. The accuracy of factual statements and the opinions expressed are the responsibility of the authors alone and do not necessarily reflect the opinion of the officers, directors, or members of GPI.

SECTION I: THE COLLABORATIVE ART OF PRODUCT IDENTIFICATION

One of our goals at GPI, and the purpose of this publication, is to help you arrive at the most cost effective combination of materials, printing, and fabrication processes that will enable your product to be well identified and beautifully decorated. This will result in a profitable return to your organization and the supplier who worked with you. In other words, the business relationship must be a business partnership.

This section will provide the designer, engineer, and buyer of identification products with an overview of commonly available products and processes. For more specific information, refer to the remainder of this manual and/or consult your supplier.

I.1 TYPES OF DECORATED METAL AND PLASTIC IDENTIFICATION PRODUCTS

There are many categories of identification products. This chapter will list typical types and combinations.

METAL SUBSTRATES

Being an opaque material, metal must be decorated by applying the imagery to the first (upper) surface. This can be achieved by any one of, or a combination of the following methods:

Printed Imagery

Lithographed, screen printed, photosensitive, pad printed, digital, or flexographically printed products usually require a top coating to increase abrasion and chemical resistance, and for aesthetic design considerations. A wide range of colors and designs are obtainable, including many decorative effects. Always check with your supplier regarding your specific requirements.

Etched Imagery

Areas of the metal are masked off with an acid resistant material which allows the unmasked areas to be etched away, resulting in the masked areas remaining in relief.

This is a very permanent marking method, to be used where long life, abrasion resistance and beauty of relief are desirable. Common substrates are aluminum, brass, and stainless steel. Check with your supplier regarding lettering height, stroke width, and depth of etching obtainable.

Embossed Imagery

Embossing is commonly done on metal substrates to achieve highly decorative effects, often in combination with other processes. Embossed copy, forced above the first surface, is achieved by an engraved or etched die mounted in a punch press. The metal substrate can be as thin as .003" (.076mm). To obtain good embossing without an "oil-can" effect, limit maximum height of embossing to the thickness of the substrate, and the stroke width of letters embossed to a minimum of three times the substrate thickness.

It is very important that you work closely with your supplier when considering embossing so the dies, printing plates, substrate alloy, and thickness can be properly engineered.

Stamped Imagery

Generally used for marking of dog tags, tool tags and storage tags, stamped imagery involves indenting a steel lettering numbering die into the metal. This process is often used to add variable data, or serial numbers to nameplates that are mass produced using another printing process.

Engraved Imagery

Engraved imagery is ideally suited for very limited production, or when many individual nomenclatures are required. Even though it is still used for some special metal applications, this process is commonly associated with two-level plastic substrates.

The major uses on metal are for identifying parts in finished form where extra deep cuts are necessary, where nomenclature must be a permanent part of the material, and where a higher degree of accuracy is needed for calibration than can be obtained by etching or printing.

Commonly referred to as pantograph engraving, the type or pattern is mounted on the machine and traced with a stylus, which moves a revolving cutter, thus engraving the nomenclature. Process limitations are slowness, stroke width of cutters, and rounded letter styles.

Anodized Imagery

Anodized nameplates and panels are produced by processing aluminum sheet chemically to harden the finished surface, and to apply anodic color. The result is a decorative and extremely durable product. One or more colors may be applied in register. Unlike with etching processes, no metal is removed. Smaller parts, edges and holes generally are not anodized, unless specifically requested.

Larger panels are commonly color anodized after fabrication to achieve permanent color on edges and inside holes.

Photosensitive Imagery

There are two types of photosensitive nameplate processes: photo etched and photographic. Both are suited to the manufacture of short runs, prototypes or applications where there are many copy changes. Resultant plates are very durable.

The photoetch process is used with all common nameplate metals. A photoresist coated plate is exposed to light through a film negative, the resist is selectively removed by developer, and the base metal is then etched to produce the graphic image. The result on aluminum is etched natural aluminum copy on a contrasting anodized background color.

The photographic process is only used with anodized aluminum. A silver compound impregnated plate is exposed to light through a film negative. The latent photographic image is then developed, fixed and sealed to produce a black image on an anodized background, which may be natural or in color. The resultant plate is the most durable of any produced on aluminum because of the permanence of the silver image sealed into the anodized layer. This process is often called for in military specifications, or in any applications that will be subjected to extreme environmental conditions or outdoor exposure.

PLASTIC SUBSTRATES

One of the most significant changes taking place within the product identification industry has been the dramatic increase in the use of plastic substrates.

The reasons for this increased use of plastics are:

- The substrates are lightweight, flexible, and may be transparent or translucent.
- They are ideally suited for front panel backlighting, digital readouts, deadfronting, etc.
- Abrasion-resistant finishes may be applied, thus reducing surface blemishes and cosmetic rejection.
- Second surface (sub-surface) printing results in totally protected imagery.

Second Surface Printed Polycarbonate, Polyester, Vinyl, etc.

Being transparent materials, plastics may be printed on the second (back) surface, or on the front (top) surface, or in combinations thereof. Processes include screen printing, lithography, flexography, digital and hot stamping. Adhesive, if required, may cover the image offering additional protection. The inking system and the adhesives must be compatible, otherwise rewetting of the ink will occur, often with unsatisfactory results.

After printing, and especially if adhesive is not applied, the second surface may receive a clear coat, or it may be cold laminated for maximum durability.

First Surface Printed

This type of product can be printed using the same processes as on the second surface, and may be coated for maximum protection. White and other very light colors may be first surface printed in order to achieve maximum color chroma.

The first surface may be coated to improve abrasion and chemical resistance.

Opaque Polycarbonate, Polyester, Vinyl, etc.

Opaque plastic materials are decorated by applying the imagery to the first surface. All printing processes may be employed. The image can be protected by applying a clear coating, or with cold or hot laminating of a plastic material to the first surface.

Etched Aluminum-Plastic Panels

Etched aluminum-plastic panels provide a method of achieving a decorative metal look while combining the feature of backlighting. The aluminum and plastic are first bonded together with adhesive. The aluminum is then decorated, after which an etch resist is applied and the lighted areas are etched away, including the adhesive. Check with your supplier on minimum size graphics stroke widths and other decorative effects are obtainable.

Polycarbonate-Aluminum Panels

This construction normally employs a second surface printed plastic substrate, such as polycarbonate, and a rigid metallic substrate, such as aluminum.

After printing, the polycarbonate overlay is bonded to the subpanel with pressure sensitive adhesive. Backlighting, deadfronting, and clear windows are some of the features that may be incorporated.

Computer Imprinted Labels, Nameplates

A number of substrate manufacturers now offer thin, adhesive-backed materials that can be imprinted by computer driven devices such as dot matrix, laser, or thermal transfer printers. Available in polyester, vinyl, and aluminum, these specially coated substrates allow the end user to add specific information to generic labels. Since each method of imprinting requires a different substrate coating, the supplier should be informed of the type of printer used to insure the best results. Ask your supplier for details.

Tamper-Resistant Nameplates

A number of materials and/or printing processes are available to prevent tampering with, or removal of, an identification product. Consult with your supplier as to which system best meets your requirements.

I.2 DESIGN CONSIDERATIONS

For aesthetic, as well as economic considerations, the following factors must be considered when designing product identification.

TOLERANCES

Critical or “tight” tolerances will increase the cost of any product, as well as the cost of any tooling required. If sizes can be made coincidental with standard dimensions, tooling may already exist, and it may be possible to avoid considerable unneeded expense. On many drawings, graphics are accorded the same dimensional tolerances as functional parts, and thus may be “over-specified.” This may be unnecessary for the intended purpose of the graphic features or product identification.

COLORS

The number of colors will have a direct bearing on the price of product identification. If possible, standard or recognized industry colors, such as the Pantone Matching System (PMS), should be specified. Specially formulated colors and exact color matches may increase costs considerably. For more information, please refer to Section 1, Chapter 6: Color Evaluation.

FASTENING

Determine the method of attachment using either mechanical fasteners or adhesives. Product identification is attached more firmly and with less expense on flat, smooth surfaces, than on textured or curved surfaces. Adhesive and material selections are extremely important. Please refer to Section 1, Chapter 8: Methods of Fastening.

ENVIRONMENT

Consider the type of environment the product will encounter. Special materials and methods are required for special conditions of use. Does the product need to be permanent, tamper evident, removable or destructible? Will it be subjected to the extremes of weather, or to a corrosive or humid atmosphere? Materials are available for virtually all applications.

QUANTITIES

Quantities are an important consideration. Ordering in larger quantities will result in lower prices per part. Quantities must be specified so the most appropriate manufacturing processes and materials can be selected, and proper tooling can be designed.

FINISHES

Most substrate materials are available in a range of surface finishes. Surfaces may be polished, glossy, clear, matte, brushed, grained, textured, or any one of many special effects that most manufacturers are capable of supplying. Cost of the finished product will vary, depending on the type of surface specified.

SPECIAL APPROVAL OR STANDARDS

If Underwriters Laboratories (UL) or Canadian Standards Association (CSA) approval is required, or if government specifications are necessary, special manufacturing processes and/or materials may be required. Such requirements should be noted in the initial specifications.

I.3 ARTWORK/COPY PREPARATION

For most types of product identification, creating production ready artwork is the first step in the manufacturing process. Most manufacturers have in-house art departments for producing finished artwork, and actually prefer to create the artwork for its desired end use.

Even artwork which has been supplied by the customer as “camera ready” or in computerized files must be made production-ready. The design requirements of the chosen manufacturing method must be considered when the art is created. It is often easier and less costly to start anew than to try to fix improperly designed artwork.

ARTWORK

Most artwork today is created electronically but, artwork can be generated using information derived from blueprints or sketches, or from existing parts. It is important to clearly specify all dimensions, hole sizes and locations, sizes and styles of lettering, as well as borders, bosses, and other special features. Special layouts, lettering, schematics or diagrams, (if being done for the first time) usually will be produced by an artist.

Having existing camera-ready artwork available for trademarks or logos can save considerable time and expense. Many companies will make this material available to suppliers, in the interest of attaining uniformity of product identity, while avoiding the

possibility of error and cost of recreating. An art department will clean up and/or color separate customer furnished logotypes or trademarks, but will not normally create or design this material. When reproducing trademarks or logos, it is always good practice to obtain permission for reproduction from the owner in writing. Use of third party logos requires specific authorization to avoid copyright or other legal issues.

To insure maximum detail and dimensional accuracy, artwork is normally prepared in a larger size than required. Thus, imperfections, dimensional differences, etc. will be minimized when the artwork is reduced to its finished size. Artwork that is prepared two times as large as the required size is called "2x", three times is "3x" and so on.

ELECTRONIC ARTWORK

The digital age has dramatically improved the quality of artwork used in production of graphic and product identification products. Electronically created artwork goes from creation to finished film in one generation, thereby avoiding problems in the loss of resolution typical of the photomechanical process.

STANDARDS

Normal minimum height of lettering is as follows:

PROCESS	HEIGHT
Etched	.063" (1.6mm)
Screen Printed	.063"-.094" (1.6mm-2.4mm)
	.063"-.047" (1.6mm-1.2mm)

Lithographed
Tolerance: 10%

Smaller lettering may be used for certain applications; be sure to check with your supplier.

In general, letters, numerals and artwork will be produced to the following tolerances, whether manufacturer or customer supplied:

1. Minimum width of .008" (.203mm) for positive type and lines.
2. Minimum line width of .015" (.381 mm) for negative (reversed) type and lines.
3. Minimum counter size of .020" x .020" (.508 x .508mm) for centers of A, e, etc.
4. Color-to-color registration should have a minimum of .010" lap (.254mm).

While keeping the above tolerances in mind, an experienced artist will also consider the following factors when designing and preparing artwork:

- A. Size and fabrication tolerances specified on drawings.

- B. Method(s) of printing to be employed.
- C. Method(s) of manufacturing, i.e. screen printing, etching, lithography, embossing, photography, etc.
- D. Type of substrate, i.e. metal, plastic viewed first or second surface, decal, etc.
- E. Positive or negative copy and graphics.

PROOFS

When the artwork is completed, it is standard industry practice to submit a "proof" for the customer's approval. A proof is a reproduction of the artwork that will be used for production. It is the customer's responsibility to carefully check the proof for accuracy of spelling, graphics, dimensions, hole and window locations, etc.

Normally, an approval acknowledgment form is sent to the customer with the proof, and work does not begin until the signed approval form, or other confirmation of approval, is received by the supplier. Thus, an unnecessary delay in art approval will delay delivery accordingly. Upon approval of the artwork, any further changes will be at the customer's expense.

Artwork produced by the supplier will normally be quoted and invoiced as a separate, extra charge. Because artwork is viewed as a "setup" cost of producing a specific order, typically artwork remains the property of the supplier unless otherwise agreed prior to order acceptance.

I.4 PRINTING METHODS

Nameplate, label, panel and decorative trim manufacturers employ most of the basic printing processes used in the commercial printing industry. Unique to the industry is the way in which these basic printing methods have been modified to enable the transfer of a very permanent image to metal and plastic substrates.

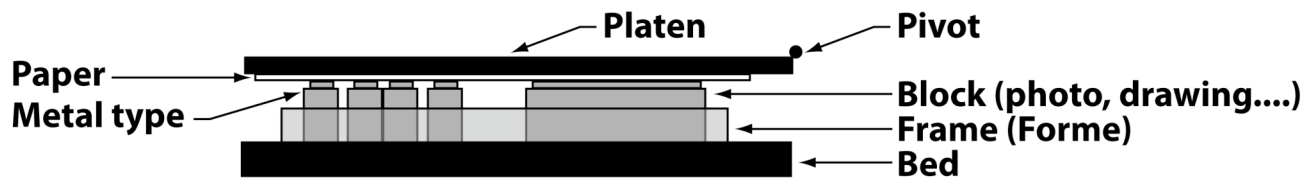
The purpose of this section is to help the designer, engineer and buyer of nameplates and panels to better understand the printing processes, and especially the advantages and limitations of each. It is important to know that the manufacturer will choose the process that will result in the best possible finished part, taking into account the number of parts, type, substrate material, special lighting requirements, light fastness, functionality, abrasion and chemical resistance, and most importantly, the intrinsic quality and appearance of the part. Quite often these factors will require a combination of processes to improve quality and reduce cost. A typical example would be to screen print a solid background color and lithograph a fine-line image.

Each process has distinguishing quality and appearance characteristics. The customer should understand these and feel free to discuss them with the

manufacturer, to eliminate delays or costly changes after the first production or prototype run is completed.

Although there are many printing processes, the five described here will account for the vast majority of work done by label, nameplate and panel manufacturers. The characteristics outlined in these brief descriptions will help you to understand how selecting a given process will produce a specific result.

LETTERPRESS



LETTERPRESS PRINTING INK FOUNTAIN PLATE CYLINDER IMPRESS
CYLINDER SUBSTRATE

Letterpress is the oldest and most versatile of the printing processes. Its name describes the printing method; raised surfaces are inked and then pressed onto the substrate material, such as paper, fabric, plastic film or metal. Thus, letterpress is the only process that uses the typeface directly. Inked rollers transfer ink to the top surface of the raised letters or images; the surrounding (non-printing) areas are lower and do not receive ink. This inked image is then transferred directly to the printing surface.

Letterpress inks are of a heavy, highly viscous paste consistency that results in a sharp, crisp image. Because the printing plates are made of metal or rigid plastic, they can be stored indefinitely, then quickly and easily used for reprints.

The letterpress process is most easily adaptable to other converting operations such as die cutting, scoring, perforating and embossing, many of which can be done simultaneously while printing. This process is ideally suited to short runs, multiple copy changes, high-quality label work, hot stamping, embossing and serial numbering.

FLEXOGRAPHY

Flexography is directly related to letterpress in that it also prints from a raised image. The printing plates are made of either rubber or photopolymer plastic material, from which the word “flexography” is derived. Flexographic presses are always of the web-fed (rotary) type.

Flexographic inks are fast-drying, solvent, water-based, or UV cured inks that contribute to very high speed printing – speeds of more than 300 lineal feet per minute are possible. Typically, regardless of the ink system, ink film deposits are very thin and transparent, a fact that should be considered in the design of the printed piece.

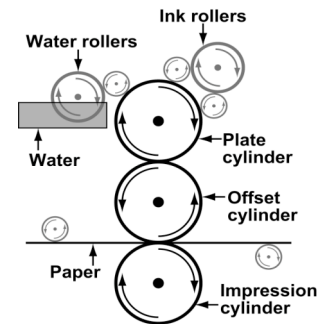
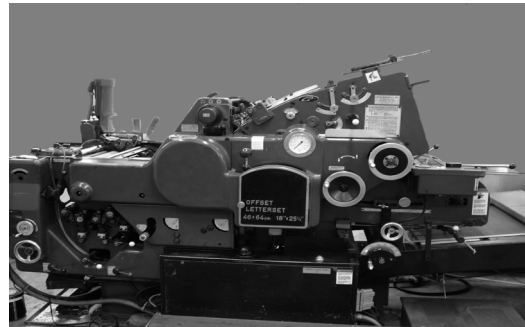
Any substrate material that can go through a web press can be flexo printed. Some materials may require special surface treatment such as priming or corona treating to enhance ink adhesion. All types of adhesive backed materials, paper or plastic, can be simultaneously printed, laminated, perforated or sheeted and delivered in roll or sheet form. Halftones as fine as 200 lines per inch can be printed, but typical line screens are 150 or 175 lines per inch. The process is also well suited for printing large areas of solid color.

Once thought of as an inferior quality printing method, flexography has benefited from improved plates, better inks and sophisticated presses that have allowed the process to rival or surpass both letterpress and lithography for print quality, color brilliance and economy.



FLEXOGRAPHIC PRINTING INK FOUNTAIN FOUNTAIN ROLL
ANILOX ROLL PLATE CYLINDER IMPRESS CYLINDER SUBSTRATE

OFFSET LITHOGRAPHY



LITHOGRAPHIC PRINTING INK FOUNTAIN SUBSTRATE
PLATE CYLINDER RUBBER BLANKET CYLINDER IMPRESS CYLINDER
WATER FOUNTAIN

Lithography involves printing from a smooth (planographic) surface, the image being neither raised, as in letterpress and flexography, nor lowered, as in the gravure process.

An image is created photomechanically on thin metal plates made up of both ink-attracting and water-attracting areas. Water and ink are then applied to the entire plate, and since these two liquids repel each other, a very crisp, well-defined image is obtained. Due to the delicate nature of this single-surface image, the image is not printed directly to the substrate, but rather it is transferred (offset) from the plate to a rubber blanket, then to the substrate, thus the term “offset lithography.”

Lithographic inks are heavy, highly viscous, with a higher pigment content than letterpress inks to compensate for the thin ink film that is deposited on the substance.

This process is most favored for its ability to reproduce soft tonal values and extremely fine copy. Another advantage of the offset principle is that the soft rubber surface of the blanket creates a clearer impression on a wide variety of smooth and rough materials with a minimum of press preparation. This process is ideally suited for printing wood grains, halftones, and other delicate copy.

Most lithographic presses used in the industry are of the sheet-fed type. Quite often the printed sheets are delivered directly into either ultraviolet or infrared curing units, after which a protective top coating is applied and cured.

SCREEN PRINTING

Originally known as silkscreen printing, this process is today more commonly called screen printing. No printing plates are involved. This process employs a mechanical or photographically produced stencil through which paint-like inks are forced with a rubber squeegee. The screen mesh is normally made of polyester or stainless steel that has been carefully stretched over metal frames and then locked into the printing presses.

Screen printing is the most versatile of all the processes. Virtually any substrate can be printed, in almost any shape, size or thickness. The solvent and resin systems available in screen inks, combined with color strength, make them ideal for printing on plastic substrates such as vinyl and polycarbonate.

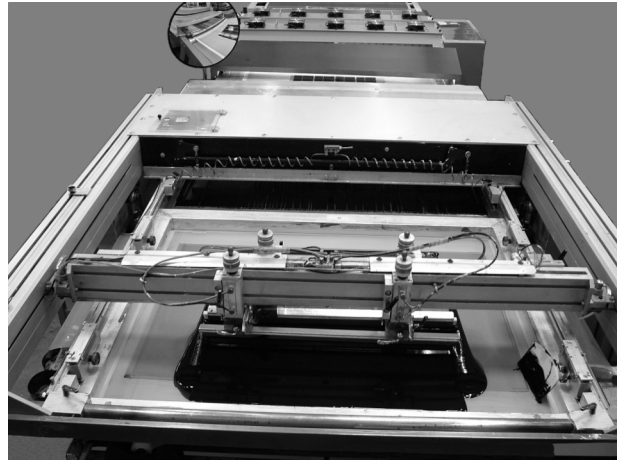
The single characteristic that sets screen printing apart from the other processes is the unusually thick ink deposit possible with a single impression. For nameplate and front panel printing, this feature provides superior abrasion and chemical resistance along with the ultimate in light fastness (ability to resist fading). It is also this thick deposit of ink that makes screen printing the most common method for printing conductive inks for membrane switch circuitry.

Of all the processes, screen printing has made the most advances in the past several decades, to where it now competes with lithography for fine line reproduction. This has come about as a direct result of developments coming from the printed circuit industry.

With the aid of fixtures and jigs, screen printing presses can be used to print rounded and other irregular shapes such as tubes, and bezels, along with a variety of injection-molded and metal parts.

PHOTOSENSITIVE PRINTING

Some nameplates are printed by photographic or photosensitive methods. A special section devoted to these alternate printing techniques is found in Section II, Chapter 4: Etched Nameplates.



SCREEN PRINTING
SCREEN
SQUEEGEE IMAGE
SUBSTRATE

HOT STAMPING

As the name suggests, hot foil stamping uses a combination of foil ribbon and heat to obtain a printed image. Hot foil stamping uses a magnesium, zinc or brass printing plate normally chemically etched or engraved to create a reverse image. Heat, pressure and dwell time are the elements used to transfer the foil from its carrier.



The foil itself is constructed of several layers: the main carrier is clear polyester coated with a release adhesive; this in turn is coated with either a pigment ink or a metallization; the final coating is a heat sensitive adhesive.

Hot stamping is used in many different applications: cosmetics, pharmaceuticals, liquor, automotive and point of sale decals to name a few. Both sheet fed and roll-to-roll equipment are used.

The main advantages of the hot foil stamping process is it can be applied to almost any substrate. The foil gives a high opacity printed image much better than that of Flexo or Letterpress printing. The process is especially useful for block colors and when printing on clear material applied to dark products.

Hot stamping can be used in conjunction with embossing and bright metallic colors to add a high value image to a product. One typical use, for example, is on wine labels. It is a clean process that permits rapid color changes and requires no clean-up time.

DIGITAL PRINTING

Digitally printed images are typically created via a 4-color process. Through a raster image processor (“RIP”), data from PostScript and other high-level languages is translated into dots or pixels in a printer or image setter. The transfer of the dots or pixels onto a substrate allows digital printing to offer the highest resolution of any printing process. Also, because no plates or templates are required, digital printing is the ideal method for both on-demand printing and for printing variable data.

There are a variety of digital printing technologies and we will cover the main ones here. Ink Jet is the most commonly used technology today. From desk top solutions to 16-1/2’ Grand Format presses, a wide array of companies provide ink jet hardware solutions, and a variety of head technologies drive a wide array of moving ink to substrate. Ink jet technologies include but are not limited to: Continuous Flow, Drop-on-Demand, Thermal inkjet, and Piezoelectric. In addition to ink jet technologies, digital printing also includes electrostatic, thermal printing and dye sublimation, just to name a few.

Continuous inkjet printers create a steady stream of ink, deflecting drops electronically onto the printing medium. Continuous inkjet typically uses solvent-based inks.

Drop-on-Demand inkjet printers use print head nozzles that each eject a single drop of ink only when activated. Thermal inkjet and piezoelectric are the two most common drop-on-demand technologies.

Thermal inkjet printers use heat to generate vapor bubbles, ejecting small drops of ink through nozzles and placing them precisely on the surface to form text or images.

Piezoelectric inkjet printing technology pumps ink through nozzles using pressure. The print head regulates the ink by means of an electric current passed through a material that swells to force ink onto the substrate.

Electrostatic Printing takes electrically charged powdered colorant particles and applies them to an image carrier which is then transferred and fused to a substrate to form a permanent image.

Thermal Printing transfers inks (resin or wax) from a foil or ribbon onto a substrate through a heated (thermal) print head.

Dye sublimation is a process that vaporizes colorant with heat and pressure and deposits it onto a substrate in order to simulate an image.

Digital images are created primarily via 4-color processes and as such, color matching abilities are limited. Also, the different digital technologies offer different levels of both color fastness and durability; in many cases, a laminate or topcoat may be required.

I.5 PRINTING INKS

Selecting of an optimal printing ink can best be achieved by analyzing the proposed end use and specifications provided by the customer. Once the proper parameters have been determined, a suitable ink can be chosen. In many cases, ink selection will drive the printing process.

A brief description of several different types of inks that are presently available to the industry follows. For the sake of simplicity, the ink types will be referred to with common names and the chemical groups will be generically characterized.

BAKING ENAMELS

While there are a number of reactions that can be initiated with heat, only a few are utilized on a regular basis in organic coating formulas and, specifically, screen process printing inks.

Alkyds

One of the earlier developments was the alkyd baking enamel, in which the alkyd is usually reacted with a melamine or another hydroxy-seeking cross-linker. Most of

these coatings require the use of a catalyst compounded by the manufacturer. Because a catalyst is used, however, shelf life may be limited to as little as six months for some colors.

The weatherability of an alkyd based on soybean oil, and/or castor bean oil, is excellent. These enamels find use on products that are exposed from five to seven years of average Midwestern weather cycles. Modifying certain alkyds with silicone resins (not silicone fluids) will yield coatings with even longer exterior durability.

Most baking alkyds cure at a relatively high temperature compared to other types of backbone polymers. A backbone polymer is the largest percentage of a polymer in an ink formulation. This may be a disadvantage since oil-containing alkyds have a tendency to yellow when exposed to excessive heat. As a result of overbaking, light colors and transparents may be affected. If this becomes a problem, oil-free alkyds that will not yellow are available.

As a general purpose coating, however, the baking alkyd is hard to beat.

Acrylics

Many of the same positive characteristics of alkyds are also found in acrylic baking systems: weatherability, adhesion, formability and chemical resistance. In addition to these properties, acrylics also offer excellent resistance to yellowing when exposed to excessive heat.

During the 1970s energy shortage, research on low-temperature-cure ink systems was accelerated. Reactions between some new generation acrylics and “low temp” melamines were developed to satisfy the demand for energy efficient coatings. Temperatures as low as 200° F for a dwell time of ten minutes can develop sufficient cross-link density to yield tough, durable coatings adequate for the automotive, appliance, and nameplate industries. While application characteristics and shelf life of the early versions left something to be desired, today, most of these problems have been solved.

The most appropriate use of this type of acrylic coating should be on nameplates, signs and other applications where exterior exposure is involved.

Epoxies

Good weathering durability is not always required in the manufacture of nameplates, signs and appliance control panels. Where this property is not important, one-component epoxies are available that will provide film properties superior to those of the acrylic and alkyd systems. The three outstanding properties demonstrated by one-component epoxies are flexibility, adhesion, and chemical resistance. Where bends are required, the epoxy, because of its flexibility and good adhesion to mill-finished aluminum, is an excellent choice. As the result of a quality conscious industry, chemical resistance specifications of epoxies have been upgraded and reinforced. The one-component epoxies meet the durability challenge exceptionally well. For example, 48-hour contact with typical spot removers has no effect on the film.

Another epoxy “plus” derives from the fact that the backbone polymer is extremely high in molecular weight, which generates a very smooth and aesthetically pleasing film. Gloss as high as 107 has been measured on a 60 degree gloss meter.

Two-component epoxies find less utility in the nameplate industry because of their inherent rigidity and the fact that two-components are more troublesome to work with. Otherwise, this type of ink or coating excels in many other areas.

Urethanes

Like the epoxies, polyurethanes are available as both one- and two-component systems. In both cases, isocyanates are reacted with polyols. In the one-component urethane, the isocyanate is chemically blocked with heat- sensitive agents that will break away when exposed to a specified temperature. The isocyanate will then react with the polyol. Polyols may come in the form of acrylics, polyesters, high molecular weight epoxies or many other polymers with hydroxy reactive sites.

Also, like the two-component epoxy, the two-compound urethane is used less because of it's limited pot life. In addition, unblocked isocyanates are very hydroscopic and will lose their effectiveness if exposed to even small amounts of moisture.

When selecting a urethane coating, remember that urethanes based on aromatic isocyanates are not suitable for exterior use. If weather resistance is required, choose an aliphatic based isocyanate.

As a class, polyurethanes provide high quality coatings that are tough, abrasion resistant, flexible and can be extremely high in gloss.

AIR DRY SYSTEMS

All of the previously mentioned coatings require either heat or a co-reactant to initiate curing. There are two other types of coating that will cure without either.

First is the air dry enamel that cures through the process of auto-oxidation. Manufacturers incorporate metallic driers into the ink system the cause an interaction with oxygen in the air. This is a two-step reaction that will result in a totally cured film in about seven days. Most inks and coatings utilizing this process appear to be cured and are able to be handled in several minutes to several hours, depending on the type of formulation.

The second type of air-dry coating is the solvent evaporative type, in which the coating is considered completely cured after the solvent has left the film. Most thermoplastic acrylics and vinyls are of this type. Second surface printing on polycarbonate is a popular use of the solvent evaporative type, because abrasion and chemical resistance are not critical.

ULTRA VIOLET CURABLE SYSTEMS

A departure from conventional coatings is evidenced in the ultra violet (UV) curable ink systems. A new set of rules should be observed with the use of UV inks. Since they are by design 100% solid liquid (the polymer itself is a liquid), no solvents are used for thinning. When printed and exposed to an ultra violet light source, up to 99% of the liquid is converted to a solid ink film. Where volatile organic compounds are of concern, the nearly total conversion is a particular benefit.

ULTRA VIOLET CURABLE COATINGS

In the screen printing industry, ultra violet curable coating has allowed a number of advantages by affording a durable and decorative, yet cost-effective finish on a number of substrates. The popularity of screen printing on UV curable coatings has grown considerably with little understanding of the advantages of UV curing, the equipment available, the ink systems and potential problems.

UV cured coatings must be “cured,” not dried. Conventional methods of drying solvent or water based inks have no effect on UV inks. UV inks must be dried by photochemical reaction utilizing lamps generating high intensity wavelengths. The ultraviolet radiation is absorbed by photoinitiators, causing them to split and become free radicals which then attack unchained monomers and oligomers creating a solid chained network of stable polymers. Thus we create a surface that is insoluble to solvents and becomes abrasion resistant.

UV inks, as mentioned before, must be cured. Curing occurs almost instantaneously, thus allowing high speeds when printing. The high speed and low temperatures of curing minimize distortion of substrates, allowing traditionally thermosensitive materials such as styrenes and other materials to be printed while limiting distortion experienced in today's “jet-air” dryers.

UV inks, relatively high in cost per gallon, usually can be a cost-effective method of printing because of their ability to cover more surface per gallon than solvent based inks; when labor costs are examined, the speed of printing UV inks more than offsets the additional cost per gallon.

Many substrates may be printed with UV inks paper, cardboard, nearly all plastics, aluminum, copper, glass, some textiles, P.C. boards and other materials. However, some materials require pretreating or sizing before application of UV inks.

UV inks, although not a panacea for all printing, have definite advantages over solvent based inks due to higher flash points, lower emission of pollutants in the atmosphere, quicker cleanup, and higher printing speeds. UV curing requires considerable technical expertise to produce optimum results.

	UV/Air	UV/Inert
Initial equipment cost	low-moderate	high
Operating cost	low	moderate
Process control	moderate	high
Textures available	limited	unlimited
Solvent resistance	moderate-high	high

Stain resistance	moderate	high
Abrasion resistance	moderate-high	high

I.6 COLOR EVALUATION

Color evaluation is an extremely critical element in all of the printing processes; but, unfortunately, it is influenced by a great deal of subjectivity. Many physical variables, opinions and methods tend to compromise evaluation standards and weaken quantifiable data.

However, customers have intensified their demands for sophisticated color matching, color consistency and color quality to such a degree that our industry must address the issues that best represent our current practices. Therefore, this chapter is intended to define reasonable standards, tolerances, measurements, requirements and limitations for color control in the graphic and product identification industry.

We caution the reader to remember that an objective description of color comparison always depends on the sample itself, the light source that the sample is being viewed under, and the human observer.

Note that since evaluation for transparent colors is covered in Chapter III.2, this section will concentrate on opaque colors and opaque printing. Typically, this refers to Letterpress, Flexography, Lithography, Photo Sensitive, Hot Stamping, and Screen Printing.

DEFINITIONS

- A. Color - the quality of an object of substance with respect to light reflected by it, usually determined visually by measuring hue, saturation and brightness of the reflected light; saturation or chroma.
- B. Hue - the property of light by which color is classified as red, blue, green, or yellow through the spectrum.
- C. Chroma - intensity of hue, purity, and saturation of color: color strength.
- D. Value - brightness, relation to gray or degree of lightness to darkness (white to black).
- E. Opacity - degree of opacity of color..
- F. Reflectance - ratio of intensity of reflected light to the surface.
- G. Spectrophotometer - an instrument for making photometric comparisons of color by measuring wavelengths.
- H. Standard Color Match - an approximate color match that will closely compare with the customer's designation of a standard ink or standard color chart

selection provided by the manufacturer. A nominal non-recurring charge is usually assessed.

- I. Precise Color Match - an exact color match of a customer-supplied chip within defined tolerances based upon agreed measurement methods. This requires extra time, material and cost and, therefore, a more substantial charge is usually assessed. Note that with some pigments or substrates, a precise match cannot be accomplished.
- J. Color Chip - sample of a color to be matched or referenced. Chips usually are on either coated or uncoated paper stock in a size ranging from 1/2" x 1" to 3/4" x 1-1/4". Chips to be used for the spectrophotometer method normally are larger to better accommodate the photo sensor. These sizes range from 3" x 3" to 3" x 5".
- K. Illuminate - intensity of light falling at a given place on a lighted surface.
- L. Kelvin - an absolute scale of measurement for temperature used in measuring light candle intensity.
- M. Metamerism - a scientific description of a common color phenomenon: two color samples that appear to match under one light source no longer match when viewed under a different light source due to different spectral reflectance curves.
- N. Daylight - defines a blue/white light source with an intensity of 6500 degrees Kelvin.
- O. Incandescent Light - a yellowish-red tone light source with an intensity of 2400 degrees Kelvin.
- P. Cool White Fluorescent - a white light source with an intensity of 4400 degrees Kelvin.
- Q. Nanometer - a unit of length used to describe the wavelength scale; equal to one-billionth of a meter.
- R. Wavelength Scale - basic element in color measurement defining lengths of light oscillation that represent a spectrum of colors. The range of the human eye is 400 to 700 nanometers.

MEASUREMENT METHODS

Visual

The most elementary and common method of evaluating color is simply to visually compare the color being processed to some form of a color chip defined or provided by the customer. This method is quick, simple and low in cost but relies on operator subjectivity and is influenced by varying light sources. Color matches can only at best be classified as "Standard Color Matches" because of the many variables affecting the measurement. The human eye alone can perceive several million different colors under optimum color matching conditions and each human has varying deficiencies in the color spectrum. This makes it impossible for the visual method to produce "Precise Color Matches" that would be quantifiable between customer and manufacturer.

The use of a viewing booth enhances the visual method. Well-known manufacturers are MacBeth, ACS and Lumax. Most booths are equipped with three or four light sources that aid the viewer in measuring color and consistency under uniform lighting conditions. Lighting sources used are the basic standards for the industry, which are:

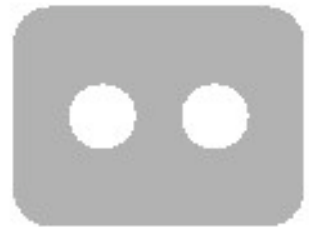
1. Fluorescent Daylight - 6500K
2. Incandescent - 2400K
3. Cool White Fluorescent - 4400K
4. Ultra-Violet A - Black light

The booth assists the viewer to detect metamerism and more accurately compare color when using the visual method. This method still requires an individual to ultimately make a subjective decision as to whether or not there is a match.

Another simple aid that helps decrease subjectivity is a viewing mask. For instance, Munsell has an N-8 neutral gray mask with two 3/8" holes, 1/2" apart. The color standard is placed under one hole and the prepared color under the other. The device reduces metamerism and ambient color influences.

Spectrophotometric

A more precise and objective method of color measurement and comparison is possible using a spectrophotometer linked with a computer. The most popular spectrophotometric systems in the industry are offered by Konica Minolta, X-Rite and Data Color. Most such systems consist of a digital spectrophotometer, a printer or a chart plotter, a central processing unit containing memory, and an operator's terminal.



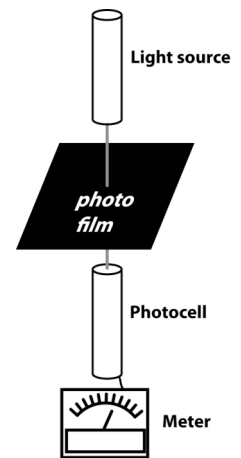
Spectrophotometrics utilizes the spectral curve to measure opaque color chips like those used in the nameplate industry. The sample is inserted in front of the photo eye and a test lamp shines onto a white screen. Varying wavelengths of color rotate through the photo eye onto the white screen producing reflectance curves that show the fraction of light reflected at each wavelength. When integrated with the light source measurements, in terms of relative amounts of power emitted at these wavelengths, the computer creates empirical values of color comparison.

An additional function is supplied by the spectrophotometric method because the computerized comparison can be fed back into the program to generate a formula printout that shows how to correct the color. This spectrum analysis provides the exact amount, in grams, of colorant required to mix and match inks. The data base created by the various data results in "Precise Color Matches," customer color mixing, in-process color consistency and a standard for quality control.

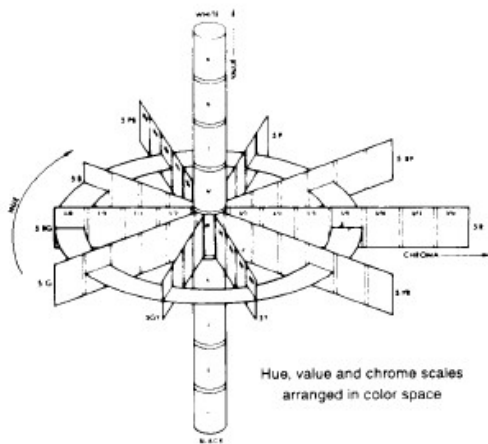
With this instrumental method of color comparison and control, the three basic elements needed to evaluate color are covered: (1) the observer (photo cell), (2) the sample (color chip), and (3) the light source (daylight, incandescent, or cool white fluorescent). The spectrophotometric method removes the human element and insures consistency.

Densitometry

Although primarily used with process colors, a densitometer is an instrument that can be used to determine spectral responses. These responses are a combined function of a densitometer's light source, filtration and sensor. When a reading is taken, light is absorbed by the ink and the remainder is reflected through a series of filters. These filters allow only light of certain wavelengths to be transmitted to the sensor. The sensor then correlates the amount of light received to the thickness of the ink-laydown on the surface. This data allows the printer to adjust either the amount of ink on the press or the saturation of color on the film in order to bring colors into tolerance.



STANDARDS OF COMPARISON



There are several industry standards used for color comparison and matching whether the visual method or the spectrophotometric method is used.

The Munsell color standard is a unique system of color notation that identifies color in terms of three attributes: hue, value and chroma. This method arranges color into orderly scales of equal visual steps and described under standard conditions of illumination and viewing. The Munsell color standards consist of opaque pigmented films on cast-coated paper for over 1500 notations. These notations are the numerical definition of the hues

arranged in the hue circuit combined with the value and chroma notation for identification. Munsell Books of Color are available with 40 standard colors in either glossy or matte finish with grid values and chroma positions. Special color chips can be created upon request and for a fee. This system lends itself to visual matching but can also be correlated with instrument data.

Pantone (PMS) is another popular color standard of identifying specific colors by number for use in the printing process. It was originally devised for offset printing but has become a common color tool with customers in all types of printing. Pantone furnishes formula guides, standards and data for matching as well as special colors upon request and for a fee. Their system is simple and easy to use for the visual method and includes over 1000 designated colors. The colors are printed on coated and uncoated paper chips and each color is numbered with a formula for mixing. Although this system is readily available, many Pantone colors are not lightfast and are not available in bases compatible with plastic and metal decorating.

PANTONE 192 C	10 parts PANTONE Warm Red 6 parts PANTONE Rubine Red	62.5 37.5
PANTONE 193 C	10 parts PANTONE Warm Red 6 parts PANTONE Rubine Red 1/2 part PANTONE Black	60.6 36.4 3.0

Federal Standard No. 595a Color is used by the U.S. government in its specifications. Most of the information in their manual is general and very broad. It does include limited tables of specific colors and glosses that can be used for visual comparisons.

CIE (International Committee on Illumination) is the most widely recognized source of uniform color scales which is known as CIE Lab. Its system and color difference equation are accurate, easily understood and commonly used in computerized color analysis. The CIE Lab System measures the objective description of color by the proper combination of sample (object), light source, and observer. It also provides the method to obtain the numbers that yield a measure of the color of a sample as seen under a standard source of illumination by a standard observer. The CIE Lab Method further quantifies color comparison by measuring the vision angle of the observer. It will calculate a reading based on a 2° angle of vision or a 10° angle. The former is equivalent to looking at a sample the size of a dime from a distance of 18 inches. The latter is equivalent to viewing a sample of 3 inches in diameter from 18 inches.

The scale of measurement that the CIE Lab program then produces for quantified comparison is denoted as DL (black to white), Da (red to green), Db (yellow to blue) and De (overall color difference). This standard is most commonly used in spectrophotometrics systems of analysis.

Other common standards available in computerized analysis are the FMC II and the Hunter systems. These are quite similar to CIE Labs base data, formulas and calculations, but simply use a different scale for comparison. The Hunter System measures/judges color from red to green, yellow to blue, and value (lightness to darkness), not hue or chroma. The FMC II System measures red to green, yellow to blue, value (lightness to darkness) and chroma or color strength.

Physical color standards must also be considered when verifying color. Color standards tend to drift in color after time and the visual will not agree with the numerical stored data in the spectrophotometer. Physical color standards should be compared with the stored data for the color standard and replaced when the physical color standard's De is out of spec. This is important because as the physical standard drifts, it may produce a De of 0 on the numeric result, but a bad visual result. This could cause inconsistencies if the color lab people decide to adjust the color visually instead of trusting the numeric results. The numeric data that was first entered in the standards data file of the spectrophotometer should never be changed.

VARIABLES

Light Source

As considered in the CIE Lab data base and calculations, the source and type of light are major variables in color comparison. Since we can't see color without light, the color depends on light and the color of a sample will appear to change considerably when viewed under different lights. It is extremely important, then, that the customer specify the light source under which the finished product will be viewed, thus eliminating metamerism.

Since the majority of nameplates and labels are used indoors under fluorescent illumination, a fluorescent light source is recommended for all color inspection whether visual or instrumental.

Gloss

Variations in specular gloss between color chip and actual production object may affect the correlation between a measured color difference and a visually perceived difference. For instance, a precise color match between a matte and a gloss finish is not possible. A color matched for a matte finish cannot be used for a gloss finish of the same color since a gloss finish will change the appearance of the color.

Angle Viewed

The central area of the retina (fovea) of the human eye is the most sensitive variable to the perception of color by an observer. As the angle of view increases above the fovea angle of 2°, the eye sees different characteristics. Therefore, industry standards have been established to cope with this by setting viewing angles to be read at a precise angle of 2° or a broad angle of 10°.

Observer (Human)

The observer is the most variable element in any color evaluation process. When observers are comparing color, they must have 20/20 vision or vision corrected to 20/20 without tinted or optic gray glasses and be unencumbered by color perception problems.

Ambient Colors

Color comparisons are directly influenced by any surrounding or background colors that may be used with the label or nameplate. Higher concentrations of energy surrounding the label/ nameplate will cause problems in color judgment by stimulating some colors and suppressing others. Again, the customer and the converter must agree on how and where the product will be used for color match evaluation.

Second Surface

Although the materials used by the manufacturers of second surface printed labels and nameplates appear to be colorless, the majority impart a yellow, blue or gray hue. Whether printing second surface or first surface with an overlamine, the printed colors can change. Customers who desire either method of construction must define the materials carefully if a color match is required, and they must be aware that material variations may cause batch-to-batch variations in the printed color. Also, if the customer subsequently changes any materials, or even the thickness of the material, a new color match will be required.

Clear Coat

The effect of adding a clear topcoat to colored nameplates will be to diffuse the spectral reflectance. The color will undergo a change in hue and saturation depending on the type of topcoat utilized. Clear resins contain a color cast that will increase saturation (chroma), making the color more vivid. Matte topcoats tend to create the opposite effect, dulling the color and decreasing the saturation. For a constant color match, it is important for the sample and the production piece to have the same amount and type of topcoat.

Inks

Although there are various types of ink (see Chapter I.5) such as vinyl, water base, alcohol base, UV, etc., their effect on color comparison is limited. This is true simply because when dealing with a color match, the ink element is only a matter of the process being used and the thickness of ink being laid down, not the ink itself.

Pigment in ink does affect color variances, but the basic formula derived for a color should create consistency. Ink color that may vary from batch to batch must be corrected by adjusting those amounts. Now, if the converter buys inks premixed, as many in the industry do, there will be variations in the ink suppliers' standard colors.. "Precise Color Matches" will be difficult to attain in those cases. Also, if pigments lack lightfastness or are not compatible with the ink or paint that must be used for the printing or decorating process selected, then color comparison will be difficult.

Durability is a more significant problem with inks than the effect of the type of ink on color comparison. The weatherability and lightfastness of the pigment is the important ingredient for achieving color quality and consistency over time. Therefore, attempting to match old colors, old inks, or weathered products will obviously pose serious problems.

TOLERANCES

Because of the subjectivity involved in color evaluation, tolerances are extremely difficult to establish. From a practical standpoint, only the spectrographic method of color comparison provides accurate measurement. With quantified readings and evaluations, tolerances or limits can be determined on which manufacturer and customer can agree. Therefore, in cases where a more than visual comparison is required or where disagreements develop, an instrument check should be made. Using the most popular instrumental standards of comparison as defined earlier in this section, the standards for tolerances are:

1. If the Hunter System is used, a delta E (total color difference) of 1.6 is considered an acceptable "Standard Match" and 0.4 for a "Precise Match."
2. If FMC II System is used, a delta E (total color difference) of 2.0 is considered an acceptable "Standard Match" and 1.13 for a "Precise Match."
3. If the CIE Lab System is used, a delta E (total color difference) of 1.0 is considered an acceptable "Standard Match" and 0.50 for a "Precise Match."

Colors off by a delta E (total color difference) of 1.6 Hunter, 1.0 FMC II or 2.0 CIE Lab will all appear to the eye as being approximately the same degree off. To make this

more understandable, an FMC II unit of measure is called a MacAdam unit. One MacAdam unit is equal to a just perceptible color difference by a standard observer. The average person usually will notice color differentials allowed by this specification but will find the variation acceptable for the intended use on most colors.

Precise color matches in the flexographic, photosensitive, and etching process are not consistently possible because of the variables inherent in the manufacturing equipment and process. “Standard Color Match” or close approximations are used in these cases.

Additionally, in the case of etching and hot stamping, the color is developed into the base material (foil, aluminum, stainless steel, etc.) by the material manufacturer. Color may vary from batch to batch, but the converter has little control over this element.

I.7 FABRICATION, TOOLING AND TOLERANCES

Specialized tolerances and quantities are key factors in determining tooling requirements. The manufacturers will “tool up” with the most cost effective tooling, such as: steel rule die, blanking die, router block, drill jig, register template, embossing die, CNC tooling, rotary die, laser, or other fixturing, based on tolerances and quantities to be produced.

The manufacturer may propose a low initial tooling cost when a prototype run is required, along with a production tooling charge based on the customer’s anticipated production quantities. There may be time and cost savings if these factors are considered during design and fabrication discussions.

NON-RECURRING PREPARATION CHARGES

It is an industry-wide practice to include all one-time preparation charges as separate items in the formal quotation. Generally speaking, non-recurring charges cover anything that must be done prior to the start of production and is not required on reorders. These “preparation charges” normally cover artwork, film work, plates, templates and fabrication tooling. Unless otherwise agreed between buyer and manufacturer, the tooling charges will be identified and separately listed, and are quite often purchased on a separate purchase order.

PROTOTYPE RUNS

A preliminary run to obtain customer approval of colors, fits, graphics layout, overall appearance and lighting is common practice. Coatings and matched color samples,

various printing process samples, and hand-fabricated prototypes made to display the finished product at a trade show or photo session are frequently required.

The cost of a prototype run can easily be justified by giving the customer and the manufacturer the opportunity to verify the entire design. Changes can then be made in order to get a consensus approval by design, engineering, manufacturing, marketing and management personnel.

MANUFACTURER TOOL OWNERSHIP

The manufacturer will engineer a specific part to fit his equipment and employ manufacturing methods to minimize tooling costs. Some dies must be assembled in separate die sets; however, in most cases the die can be engineered to fit a standard die set, thus saving hundreds of dollars.

It is often impossible to remove that portion of a tool which the customer believes to be his, based on the tooling charges made, from one manufacturer's plant and expect another manufacturer to produce parts from it. More often a complete rework of the tool is necessary.

For the above-stated reasons, it is standard practice in the nameplate, label, and front panel industry that the customer's payment of tooling charges does not convey ownership, nor the right to remove tooling without additional charges. It is also understood that tooling charges are not necessarily for complete dies, but for only that amount of preparation necessary to produce the part. This practice is a benefit to the customer.

ADVANTAGES OF MANUFACTURER-OWNED TOOLING

- The manufacturer assumes full responsibility for maintenance, within the normal life of the tool, and for producing parts within tolerances and specifications.
- The manufacturer has built the tool to fit his equipment to keep costs to a minimum (both tool and unit costs).
- The manufacturer has built a tool that is unique to his operation considering not only fabrication, but straightening, sorting, inspection and packaging operations.
- The manufacturer stores the tool free of charge during usage and normally for two years after last use.

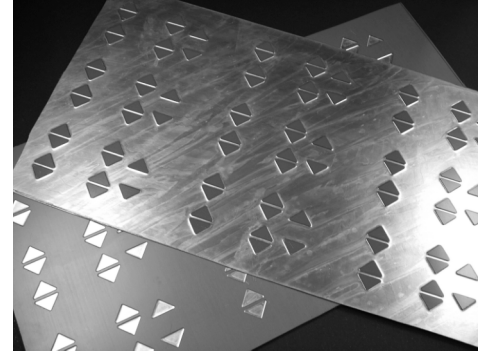
When a customer wishes to own a tool, that desire should be so stated on a separate purchase agreement. Even then, the tool must be compatible with the manufacturer's equipment and production processes. In this instance, maintenance and appropriate sales/use taxes will be at the customer's expense.

TYPES OF TOOLING

Embossing-Debossing Dies

Embossing entails imparting a design to a flexible or ductile material by compressing the material between matched, rigid, male-female dies. Embossing dies can be of either flat or rotary types. Embossing refers to designs forced above the substrate surface; debossing forces the designs below the substrate surface.

Embossing dies can be made by etching or by engraving the rigid die material. Engraving results in much less draft on the shoulder of the design, which is normally very desirable. Engraved dies are often incorporated into a registered section of a punch press blanking die, allowing both embossing and blanking to be done simultaneously. Etched dies have more draft angle due to the etch-resist method of creating the design. This results in a rounded shoulder on the periphery of the design. Etched embossing dies can be made to emboss various material thicknesses by choking and spreading the design negative. The narrowest width of any design should not be less than three times the substrate thickness and the height of the emboss not greater than the substrate thickness.



DIE CUTTING

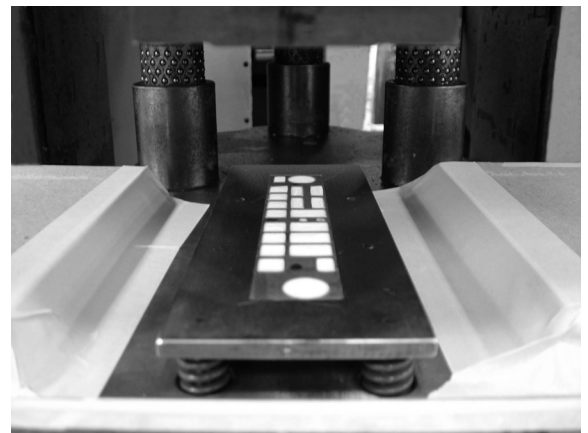
Types of Die

Jig Die

A jig die is a steel rule die in which the pattern is cut into the die board using a special jig saw. The diemaker follows a pattern line on the die as closely as possible and the resulting accuracy is therefore limited to his particular skill level and hand/eye coordination. It takes a very good diemaker to hold better than ± 0.010 " (.254mm) tolerance. If a close tolerance is not required, at least a ± 0.010 " (.254mm) tolerance should be specified on the prints. The jig die is the most cost effective type of die.

Class "A" Tooling (Hard Tooling)

Class "A" tooling must be used when material thickness is over .020" (.508mm), to cut tight dimensional tolerances less than ± 0.005 " (.127mm) and on large volume production runs. Usually more expensive than other types of die, Class "A" tooling consists of male/female die halves. Matched metal tooling operates by shearing the film.



Steel Rule Cutting Dies



Steel rule dies are the most commonly used because they are the most cost-effective and will meet the tolerance requirements in most applications. The diagram below illustrates a typical steel rule die, mounted in a die press.

Generally, steel rule dies are manufactured by use of laser machines that burn a 2 or 3 point slot in a flat die base material and then a hardened sharpened edge steel rule is machine or hand bent and inserted into this slot to create the desired finished shape of the end product. A steel rule die can be

made up of a single shape or a combination of different desired shapes that will be stamped from a printed substrate with a single impression on a die cutting press.

There are limitations to the capabilities of the steel rule die. It is essential that the tool maker be informed of the total lamination and/or substrate thickness, tolerance expectation and quantity of parts that will be cut . Maximum die life is dependent upon the construction method used to build the tooling and the following factors that affect tool life. A tool can last from one impression to many tens of thousands of impressions depending on these primary factors:

1. The substrate type and total lamination thickness of the material being cut.
2. Type of cutting process being used.
3. Whether the stroke of your die cutting press being controlled with a bearer block or hard stop system.
4. Whether the die is manufactured to the best fit standards of material type and thickness being cut.
5. The care with which the die is maintained and stored.
6. Whether the die rule is making contact with a ferrous cutting plate.

Steel rule dies wear out and eventually cause parts to be out of tolerance and have ragged or burred edges. This must be taken into account when deciding upon initial tooling costs relative to the consistent quality desired and the length of the production runs.

Normal steel rule die tolerances are ± 0.010 " (.254 mm) for hole-to-hole and hole-to-edge dimensions, and ± 0.015 " (.381 mm) for edge-to-copy dimensions. Steel rule dies can be built to ± 0.005 " (.127 mm) tolerances, but this does not assure that finished parts can be fabricated to this tolerance due to the inherent die cutting techniques involved.

Typically, the cost of steel rule die is less than the cost of a male/female hard tool. Tooling options are available now (such as combination tooling, chem-mill dies, machined cavity punch dies or piercing dies) that bridge the gap between steel rule dies and male/female hard tools.

Steel Rule Bevels

Different types of steel rule bevels are used by diemakers. The decision on the type of bevel and rule thickness (one point equals .014" [.356mm]) to be used is determined by the following variables: thickness of material being cut, specific die configuration and type of die cutting being done (kiss-cut or cut through).

Bevel Designs

The illustration below shows the most common bevel designs.

Center Bevel (CB):

With CB, the length of the bevel is equal to the thickness of the rule, and both sides of the rule have the same bevel.

Long Center Bevel (LCB)

LCB is similar to CB but ground to a longer profile.

Side Bevel (SB)

With SB, all of the bevel is ground on one side of the rule except for a small back-grid of approximately .010" (.254mm).

Punches

Punches are available in standard cutting diameters ranging from 3/32" (2.38mm) to 1-39/64" (40.9mm) in 1/64" (.40mm) increments. Sizes other than 1/64" (.40mm) increments are available but must be special-ordered, requiring additional cost and lead time. Larger diameters are normally formed from steel rule.

Punch Press Blanking Dies

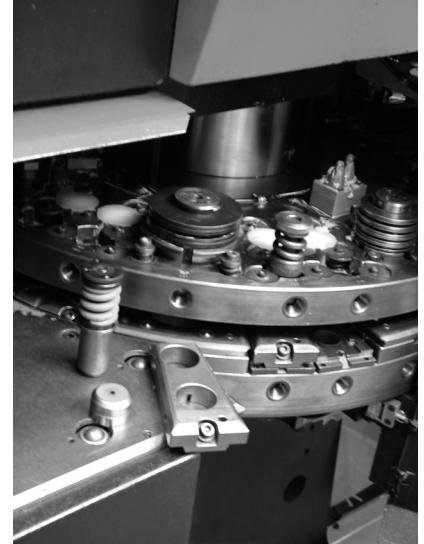
Precision punch press dies, commonly referred to as hard tooling or Class A dies, are made by trained tool makers using the best grade tool steels. Precisely fitted strippers, interchangeable die inserts and exact clearances result in nearly burr-free close tolerance parts. The punch and die are mounted in a dieset and powered by a punch press, which drives the two die sections together, resulting in blanked and pierced finished parts. The higher cost of this tooling is justified when close tolerances and long die life are production requirements.

Normal tolerances are $\pm .005$ " (.127 mm) in hole size, hole-to-hole and hole-to-edge dimensions, and $\pm .008$ " (.203 mm), hole-to-copy locations. Hole size and hole-to-hole tolerances can be made closer for additional tooling and running charges.

Punch press tools will normally produce a minimum of 100,000 parts. Normal adjustments and maintenance work are done by the manufacturer at no cost to the customer. (See - Advantages of Manufacturer-Owned Tooling).

Single Punch And Die Tooling

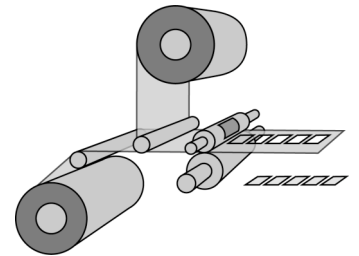
Single punch and die tooling is made using hardened tool steel, but instead of piercing and blanking during a single machine actuation, as with a punch and die set, an individual hole, slot or cutout is die cut with a single tool controlled by a template, numerical controls or CNC controls. Because the manufacturer normally has a "library" of standard size tools, the tooling cost is most often less than with punch press and dies. Typical tolerances of ± 0.010 " (.254 mm) on hole-to-hole locations and ± 0.015 " (.381 mm) on hole-to-edge and hole-to-copy can be maintained. Tolerances of modern CNC fabrication are closer than with older template controlled machines.



This type of tooling is ideally suited for small production runs, prototype runs, or panel work where Class "A" hard tooling cannot be justified. Single punch and die tooling will normally last 100,000 hits or more, providing good maintenance and common substrates are employed. Seldom is single punch and die tooling adaptable to another manufacturer's equipment. The same maintenance, storage, tax and ownership policies apply to this method of tooling as with steel rule tooling.

Rotary Dies

Rotary dies are used to accompany flexographic printing. Tolerance and life are similar to those of steel rule dies. Rotary dies are CNC engraved and surface hardened and chrome plated for durability. There are also fully hardened rotary dies that are manufactured from high-grade alloy steel for longer runs. Air eject systems can be designed into rotary dies to prevent slug buildup inside die cavities which can cause blade damage.

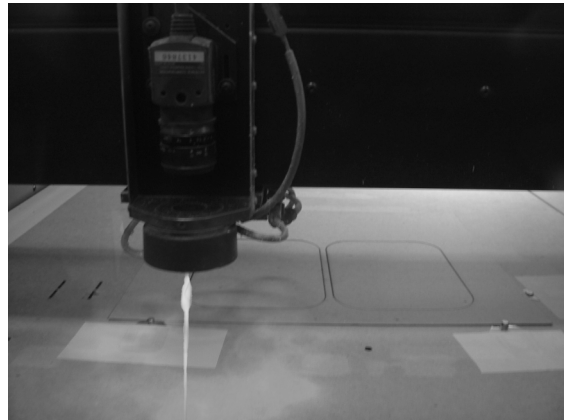


Normal rotary die tolerances are ± 0.010 " (.254 mm) for hole-to-hole and hole-to-edge dimensions, and ± 0.015 " (.381 mm) for edge-to-copy dimensions. Rotary dies can be built to ± 0.005 " tolerances, but this does not assure that finished parts can be fabricated to this tolerance due to the inherent die cutting techniques involved.

Cutting Lasers

Cutting lasers eliminate the need for upfront tooling costs. CO₂ cutting lasers are programmed on a per part basis and changes to design are just a matter of changing the program. Complex and special shapes are cut as easily as they can be drawn. CO₂ lasers can range between 25 watts and 2500 watts. Within a moving (in the Y direction) gantry are a series of mirrors by which a laser beam is directed and then

goes into a carriage (moving in the X direction). The carriage contains a focusing lens which focuses the beam onto the substrate to be cut. Registration to the substrate can occur through a traditional three point system or, can be done by finding registration targets. The laser beam itself is typically .004 to .007 wide. Normal tolerances for laser fabrication are $\pm .005$ (.127 mm) for hole-to-hole, hole to edge and, edge to copy.



Laser cutting is ideal for a number of different substrates, including stainless steel, polycarbonate, polyester, acrylic, paper, wood, glass, and others. Limitations include the inability to cut aluminums (aluminum absorbs the heat of the beam and does not cut) and vinyls (due to the creation of toxic gases).

TOLERANCES AND PRICING

Tolerance callouts must be considered when one is pricing a nameplate or front panel. Fabrication tolerances as close as $\pm .005$ " (.127 mm) are quite common in the nameplate industry, but the customer must realize that generally the tighter the tolerance, the higher the tooling and piece price. Often the tolerances shown on a print may be required for other precision components being manufactured, but are quite unnecessary for the fabrication of the average nameplate. For complex designs with many blended radii or many hundreds of dimensions, consider using profile tolerances, GD&T, and using film positive die lines to establish pass/fail zones for finished cut nameplates.

STANDARD EQUIPMENT TOLERANCES (no tooling required)

If the part has straight sides, square or standard round corners, standard hole sizes, and the substrate thickness is within tolerances listed below, it may be made on standard fabrication equipment to these tolerances:

Holes, center to center	$\pm .015$ " (.381 mm)
Holes, center to edge	$\pm .015$ " (.381 mm)
Holes and copy concentricity	$\pm .015$ " (.381 mm)
Length and width (.032" thickness)	$\pm .015$ " (.381 mm)
Length and width 063" thickness)	$\pm .020$ " (.508 mm)
Border, relative to edge of plate	$\pm .015$ " (.381 mm)
Bleed, minimum width	$\pm .050$ " (1.27 mm)

Sheared and punched edges will normally have a rolled edge up to 15% of material thickness.

DIE STORAGE AND OBSOLESCENCE

When the customer has no further use for a specific tool, it is customary to notify the manufacturer to allow clearing the valuable storage space such tools require. In the absence of such notification, the manufacturer would be correct to assume there is no further use for the tool. Standard practice is to hold the tool for a period of two years after last use, at which time the manufacturer will notify the customer of that the tool will be discarded.

BACK SIDE OF NAMEPLATES

If a mechanical, anodized, plated or a painted finish is required on the back side of a nameplate, it should be stated on the request for quote or blueprint.

A finish specification is understood to refer only to the front of a nameplate, unless otherwise specified. Normally, the supplier will select the best side of the substrate, especially if it is metal, for processing. During processing, the substrate material may pick up pits or scratches on the back side, where it may not be important from a visual standpoint. Special handling is necessary, and should be specified, if a special finish is required on the back.

RESIDUE ON FINISHED PARTS

Dies or tooling are often used in the production of nameplates. This tooling requires oiling to assure proper function of the die and to prolong its life. It must be expected that a small amount of oil will remain on some parts. To remove the oil before shipping the parts would mean 100% handling, and require an extra charge. The customer usually handles the plate in applying it to the product, and then usually removes the oil in the final cleanup operation of the end product. For this reason, it is standard practice in the nameplate industry not to put customers to the expense of paying for the handling necessary to remove traces of oil and adhesives, unless the customer specifies it at the time of bidding.

METHOD OF PACKAGING

Unless definite instructions for packaging are stated at the time of bidding, the packaging of nameplates will be done in the most economical method possible to deliver the plates in good condition.

Special packaging should be specified at the time of pricing if any of the following are required:

- Oil removed from all parts.
- 100% inspection of all parts .

- 100% accurate counting of all parts.
- Parts wrapped separately.
- Parts of a certain number per package or bag.
- Packaged for overseas shipment.
- Fungus-proof or waterproof packaging.
- Odd-shape parts.

In the manufacture of nameplates, protective films are occasionally used. It is standard practice to leave these films on to protect the parts in shipment unless removal is specified and paid for by the customer.

COMMERCIAL COUNTING

Parts may be counted by a counter on a punch press or shear. They may also be weight counted. This system of counting may vary a nominal percent from the actual count on quantity runs.

COMMERCIAL BUYING POLICY AND RETURNS

It is the policy of most companies buying nameplates to buy more than they actually need to take care of their own spoilage, for spare parts, and to use in place of a few that may, in the opinion of the assembler or inspector, be not quite good enough. When plates are purchased in slightly larger quantities than needed, the customer gets a lower price based on the higher quantity. For this reason, it is not industry policy to make refunds on the return of a few unused parts.

10% OVER OR UNDER COMPLETES ORDER

It is standard practice within the industry to run material in excess of the quantity ordered so that some may be used in trying out and setting up tooling, and to replace some spoiled in processing and to insure the completion of the order. In most instances, the customer will order the same parts at a future date.

For these reasons, the industry expects that an order be considered complete when the quantity shipped is within 10% over or under the quantity ordered, unless no over or under shipments are specified on the purchase order.

It is standard practice to have a premium charge for exact count or any deviation from this policy.

I.8 METHODS OF FASTENING

The methods used to fasten a nameplate to a product depend upon the application surface of the product, the type of nameplate, or decal, and the degree of permanence desired. Mechanical fasteners and adhesives are the most widely used methods of

fastening. Mechanical fasteners are generally used for heavier gauge metal nameplates, while adhesives are used for decals, overlays, and lighter gauge metals.

MECHANICAL FASTENERS

Sheet Metal Screws - Similar in appearance to a wood screw, a sheet metal screw is designed to thread itself through a hole in thin metal. One of several types is shown.



Drive Screws - For heavier gauge metals, self-tapping drive screws can be used to eliminate tapping of threads in the part to which nameplate is applied.



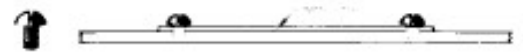
Escutcheon Pins - These are used for attaching nameplates to wood and similar materials.



Bolts - For heavier metal.



Machine Screws - For metal heavy enough to tap with threads.



Rivets - Rivets are often used where easy removal of the plate is not desired. One of several types is shown.



Tabs - Design plate with a tab extended out from each end of plate. Tabs are bent down to go through slots, then bent back to lock the plate in place.



PRESSURE SENSITIVE ADHESIVES

Pressure sensitive adhesive products play a key role as a method of fastening nameplates to substrates. Two of the more common types are transfer tapes and double-coated tapes.

Transfer tapes and double-coated tapes have similar as well as unique qualities, with many variations available to suit virtually any application. Pressure sensitive adhesives will be referred to as PSA and transfer tapes will be referred to as TT in this section.

Transfer Tapes

Definition: A self-supported PSA (there is no film carrier) protected by a release liner on one or both sides

Adhesive: Thicknesses range from .001" (.025 mm) to .010" (.254mm). Thicknesses of 1 to 5 mils are most common. The majority of transfer tapes are acrylic based because of improved internal strength, clarity, excellent outdoor and long-term aging characteristics, as well as added plasticizer and solvent resistance.

Carrier: NonRelease Liners:

Depending on the method of application, one or two liners may be required in stay-flat or roll form configurations. TT's with one liner are used when there is no contact with the exposed side of the adhesive during processing. However, if the transfer tape must be die cut before it is applied, both sides of the PSA must be protected with liners.

Special liners are available to keep TT's flat throughout processing, if required. Transfer tapes provide a simple, clean, solvent-free method of joining plastic or metal nameplates, and decals to plastic or metal substrates. Consult your TT manufacturer or supplier to insure the best possible product for your application.

Double Face Pressure Sensitive Tapes:

Definition: A fastener consisting of a PSA on both sides of a film carrier, protected by one or two release liners.

Adhesives: Acrylic and rubber based systems are available. The type of surface(s) to be bonded will determine which adhesive is best. The manufacturer may apply the same or different Psa's on each side of the carrier for bonding substrates with similar or dissimilar surfaces respectively.

The most common PSA thicknesses range from .001" (.025mm) to .0025" (.064mm) on each side of the carrier. The most important determining factor in choosing the correct PSA thickness is the surface texture (roughness) of the substrate.

Carriers: A carrier is located between the two layers of PSA and contributes to the physical strength of the product, which means production and application speeds can be significantly increased, resulting in maximum efficiency for both the manufacturer and user.

Polyester, polypropylene and vinyl carriers, in gauges ranging from .0005" (.013mm) to .007" (.178mm) are the most widely used. Carriers are available in clear, colors, metallized and nonmetallized. The types, gauges, and colors available may vary among manufacturers.

Release Liner: This is the protective paper and/or film applied by the manufacturer to one or both sides of the double-faced adhesive.

Both speed and method of application play an important part in release liner selection. If the double face is automatically applied, a liner that removes very easily from the PSA may be the best choice. If applied by hand, the release characteristics may not be as critical.

Translucent and water-clear release liners are available for applications where the double face is a visible part of the final label or panel. The smoothness of the PSA, which ultimately affects clarity, depends greatly on the smoothness of the release liner. The PSA has a tendency to exhibit the surface characteristics of the release liner. If, however, a double face is hidden (unseen) between an opaque rigid nameplate and an aluminum or plastic housing, the smoothness and clarity of the PSA becomes a much less critical requirement.

Liner selection also depends on whether the double face must remain flat during any stage of the application process. Liners are designed to keep products flat, and for 100% roll form processing.

Factors To Consider When Choosing The Correct PSA

1. Substrate Composition

It is important to identify the substrate to which a PSA will be applied. Is it plastic, i.e., high or low density polyethylene, polypropylene, polycarbonate, etc., or is it metal? Is it painted, lacquered or coated in any way? PSA s exhibit different bonding characteristics on different surfaces.

2. Texture of Substrate

A rough or textured surface will usually require a stronger bonding adhesive, or a heavier adhesive coat than a non-textured surface.

3. Shape of Substrate

Some applications may involve curved substrates, and thus require a special adhesive to provide a stronger bond to prevent the flexible nameplate from lifting at the edges.

4. Cleanliness of Substrate

The application surface must be clean! Contaminated surfaces are the major source of adhesion problems. Dirt, grease, moisture, oil, mold-release agents and silicones are examples of contaminants that must be removed prior to application.

Identify any plasticizers that may be present after the PSA fastener is applied. A plasticizer-resistant PSA may be required. If the presence of plasticizers is suspected, accelerated aging of the adhesive/substrate is recommended.

5. Application Temperature

The temperature of the substrate should fall within the recommended application temperature range for the PSA product.

6. Environmental Conditions

Special conditions such as temperature extremes, outdoor weathering and sterilization are important in making a PSA fastener selection.

Important: The PSA fasteners discussed here will be used to bond two surfaces that are similar or dissimilar. It is important to evaluate both nameplate and substrate surfaces for proper PSA selection.

7. Factors Influencing Adhesion

The prime criterion for any PSA in establishing adhesion to a substrate is that the adhesive makes surface contact or “wet out”. Factors which influence wet out are as follows:

- A. The critical surface tension of the surface to be bonded.
- B. The intramolecular attraction forces of the adhesive. (The greater these forces, the slower the wet out occurs.)
- C. The specific affinities of the adhesive to the surface that it is being bonded.
- D. The application temperature, the higher the temperature, the faster the wet out.
- E. Application pressure. (Again, the greater the pressure, the faster the wet out occurs.)
- F. Time. The time the adhesive takes to obtain complete wet out as a function of the properties mentioned above.

PSA Inspection And Adhesion Testing

Quality control of incoming materials is critical. Quality begins with the definition and communication of the end user’s requirements and the material supplier. These requirements should be established and specified based on performance testing of the end use product. Test methods and equipment are described in *Test Methods for Pressure Sensitive Tapes* published by PSIC (Pressure Sensitive Tape Council).

The suppliers of base materials should include:

1. Release Liners

- A. The carrier, which is a web or sheet of material covering and protecting the adhesive side. It is removed prior to application.
- B. The release value: a measurement of the adhesion or the force required to separate the release liner from the adhesive at a specified angle and speed. The standard test procedure is PSTC #4.

2. Adhesives

- A. Peel adhesion - The force required to break the bond between the adhesive coated part and the surface to which it is applied. Use PSTC Test Method #1.
- B. Shear (holding power) - The ability of the adhesive backed part to resist the static forces applied in the same plane as the backing. Expressed in time required for a given weight to cause a given amount of product to come loose from a plane. See PSTC Test Method #7.
- C. Tack - A measure of how quickly a PSA wets out and establishes surface contact to the material being bonded. In a real sense, it is a measure of how easily the adhesive components can flow past each other.

In addition to monitoring base materials, Standard Operating Procedures (SOPs) must be developed for manufacturing the finished product. Documentation or record keeping is essential, as any variable may cause variations in finished product performance.

The key feature of pressure sensitive adhesives is that they are always sticky. They do not need water, solvents or heat to bring out their adhesive qualities. Adhesives vary as to chemical make up and their uses. Typically, adhesives are classified as permanent or removable, acrylic or rubber based.

Adhesive Definitions

1. Permanent and Removable

Pressure sensitive adhesives are categorized as permanent or removable. Loosely defined, an adhesive with two pounds or more of peel strength from stainless steel is permanent.

A peel strength of less than two pounds indicates a removable adhesive (peel strength is calculated by measuring the amount of force required to peel a one inch wide strip of pressure sensitive from a substrate - see PSTC Test Method #1).

Permanent adhesives tend to continue to increase in bond strength with time, usually reaching ultimate adhesion in 72 hours to one week after application. Removing the permanent pressure sensitive from the substrate is difficult. Either the facestock will tear or adhesive transfer will result.

Removable adhesives reach their ultimate adhesion in one to 24 hours after application. The bond strength remains low, less than the tensile strength of the film, up to two years after application depending on the product. After this period, the adhesives may stiffen up or the facestock weaken, and the product becomes permanent.

Removable adhesives, when removed from the substrate, should not leave an adhesive residue.

Although removable pressure sensitives are removable from most smooth substrates, they may not be completely removable from matte or textured substrates. Testing the removability from painted surfaces is strongly recommended. Removables are designed to have low ultimate adhesion, but if the bond of the paint to the substrate is less than the bond of the adhesive to the paint, the paint will strip off when the decal is removed.

2. Rubber-Based Adhesives

Rubber-based adhesives were the first pressure sensitive adhesives. The rubber-based products are generally soft with good cold-flow properties; that is they flow easily into textured surfaces and quickly develop a high bond strength. They adhere well to low energy surfaces such as poly- ethylene.

Rubber-based adhesives generally have high tack, excellent water and humidity resistance, and resistance to active sol- vents containing oxygen.

The minimum application temperature for rubber-based adhesives is fairly low; usually in the 30-50 degree Fahrenheit range. The shear strength on rubber-based adhesives is low.

3. Acrylic Adhesives

In response to the need for more durable products, acrylic adhesives were developed. These adhesives are resistant to ultraviolet light, and are better suited for outdoor products. Their internal strength is good, and they provide excellent dimensional stability with vinyl products.

Water-clear acrylics are used with clear films for a glass-transparent look. Acrylic permanent adhesives have a wide performance range -65 to +300 degrees Fahrenheit and excellent resistance to water, high humidity and chemicals.

Acrylic adhesives can be made in a variety of bond strengths, with application temperatures suitable for summer or winter use. Cold temperature adhesives are designed to be applied at 20 to 50 degrees Fahrenheit.

Overlaminating adhesives are glass- clear, with good cold-flow properties to provide a smooth, even, "deep" finish to the underlying graphics.

Repositionable adhesives have low initial tack, but high ultimate adhesion.

They can be lifted and reapplied to the substrate during installation without stretching the film. After 24 to 72 hours, adhesion will build up so that the film will be damaged if removal is attempted.

4. Silicone Adhesives

Silicone adhesives are introduced where there is either exposure to very high service temperatures or a very wide range of service temperatures. These adhesives are able to maintain their bond strength in a performance range of -300°F to 500°F.

These adhesives offer good resistance to chemical and solvent exposure and perform well where there is a need to offer either moisture resistance or vibration damping.

SOLVENT ACTIVATED ADHESIVES

Solvent activated adhesives are dry films that have little or no tack before solvents are applied. Nameplates may be purchased with this type of adhesive either without release liner protection (dry back), or with a liner to protect against contamination prior to application.

This type of adhesive may be applied by the manufacturer in either as a liquid or in tape form. In liquid form, solvent activated adhesive may be applied by roller coating spraying, or curtain coating. After the coating is thoroughly dry, a release coated paper is applied. When purchased in tape form from the adhesive manufacturer, solvent activated adhesive may be applied by heat and pressure, solvent and pressure, or pressure only.

To apply a nameplate by solvent activation, one must first remove any liner. The recommended solvent for the adhesive is then applied by a brush, felt pad, spray, or roller coater. In high production, roller coating is usually used since it is more consistent. If insufficient solvent is applied, the nameplate will not adhere properly. If excess solvent is applied, some of the adhesive may be washed off, or an excess of adhesive will ooze out around the edges of the nameplate when pressure is applied. After the nameplate has been solvent activated it should be applied to the receiving surface and pressed in place by fingers, roller, or platen, and may be moved slightly into position while in contact with receiving surface.

HEAT ACTIVATED ADHESIVES

In recent years, heat activated adhesives have gained popularity. Most solvent activated types may also be heat activated. Nearly all heat activated adhesives are made of a thermoplastic material. Thermosetting adhesives are usually not used by nameplate manufacturers.

To apply a nameplate by heat activation, one must first remove any liner. The nameplate must be pressed against the receiving surface with heat and pressure. The heat may vary from 200° F and higher and pressure from 50 PSI and higher, with a dwell time of two seconds or more. The critical element of this application is that the glue line at the receiving surface must reach a temperature sufficient to make the adhesive temporarily fluid.

Heat activated adhesive usually is used on thinner nameplates and requires special equipment for application. In high-volume production, it is the fastest method of application, and furthermore, the application may be automated.

1.9 LEAD TIME FACTORS

Because product identification is manufactured as a custom product, lead times can be affected by the manufacturer's workload at the time an order is placed. However, the factors affecting lead times are greatly influenced by the customer's requirements. Some important considerations are as follows:

Dimensional tolerances are a major determinate for lead times. If material thickness or close tolerance die-cutting requires hard tooling, this will assure lead times in excess of the norm. Some nameplate manufacturers may order this tooling from die shops with lead times of six weeks or greater. Steel rule tooling is generally available in seven to ten days.

Clarity of specifications is essential to achieving quoted lead times. If a customer's print is vague or information is missing, delays result while the manufacturer clarifies these points with the customer.

Normal lead times quoted by manufacturers are not usually intended for parts with numerous colors. Generally, as the number of colors increases, lead times will be longer than normal. If a customer required special color match is specified, this will add time, not only for the color match, but for submitting color swatches and awaiting customer approval.

If the part requires a unique or special material, or one not normally stocked by the manufacturer (either type of material or special size of material), delays beyond the normal lead times can result while the manufacturer awaits delivery.

A part that is re-ordered with no changes from previous specifications will have the shortest lead time, as there will be no additional time required for preparation of artwork, or ordering of tooling.

Manufacturers recognize that there are occasions when a customer must have parts more quickly than usual. This may be accomplished by scheduling overtime work, adjusting production schedules, furnishing partial shipments, etc. It is a normal industry practice to quote additional expediting charges to facilitate a delivery in less than the quoted lead time.

SECTION II: METAL SUBSTRATES

Aluminum, brass and stainless steel are the most commonly used nameplate metals. These metals are chosen for a number of reasons, including strength durability, appearance, corrosion resistance and machinability. Several characteristics apply to nearly all metals:

HARDNESS

Hardness tests are used as an indicator to determine tensile strength. Since tensile testing equipment is expensive and cumbersome, hardness testing equipment may be used to improve incoming quality. Remember, however, that a hardness test is only an indicator of tensile strength. Acceptance or rejection of material should not be based on a hardness test alone. Several popular hardness tests used in the industry today are:

1. Rockwell Hardness Test
2. Brinell Hardness Test
3. Vickers Hardness Test
4. Knoop Micro Hardness Test

The Rockwell Hardness Test is the most commonly used in the United States because it is adaptable to a wide range of gauges. The hardness is determined by pressing an indenter into the surface under a fixed load and measuring the depth or diameter of the resulting impression. The value obtained is expressed as a hardness number. Hardness numbers are a relative measure of resistance to deformation, and an indicator of work hardening characteristics, as well as resistance to abrasion. The cost per test is low and test equipment is relatively inexpensive, easy to use, and easy to maintain.

Other recognized hardness tests are the Brinell Hardness Test, Vickers Hardness Test, and Knoop Micro Hardness Test. Brinell testing is used primarily in the ferrous metals industry, while the other tests are commonly used in research or for testing very small parts.

Hardness measurements can be affected by localized conditions at the surface being tested. As a result, it is not always possible to correlate the hardness number obtained using one indenter, load, and hardness scale. For each temper and thickness there is a preferred choice of scale to provide the most reliable data.

GRAIN SIZE

The grain size is a direct relationship to the hardness or softness of a metal. When metal is rolled, the grains become distorted or elongated in the direction of rolling. The smaller and more elongated the grains become, the harder the metal becomes. Conversely, the larger the grain size, the softer the metal. Grain enlargement is accomplished during the annealing process and re-crystallization. If an alloy is to be etched, it is important to remember that a finer grain structure results in a smoother etched surface, and vice-versa; it is therefore important to specify grain size if etched

finish is important. If secondary operations such as drilling, forming or stamping are to be performed, proper grain size should be specified. Grain size may be expressed in terms of the number of grains per unit area, or volume. Standard grain size comparison charts are available from metal suppliers.

II.1 ALUMINUM

Aluminum is the most commonly used nameplate metal. It is readily available in a wide variety of gauges, sizes and finishes, and is inexpensive compared to the other metallic substrates. It may be printed, etched, anodized, painted, embossed, formed and fabricated with relative ease.

The alloys most commonly used in the manufacturing of nameplates are 1100, 3000 and 5000 series. However, types 2024 and 6061 aluminum are also used for special applications or for ease of machinability.

ALUMINUM AND ALUMINUM ALLOY DESIGNATION SYSTEM

In specifying the composition of aluminum and aluminum alloys, a four-digit designation system is used. The first digit indicates the alloying element as follows:

- 1xxx At least 99% pure aluminum
- 2xxx Copper
- 3xxx Manganese
- 4xxx Silicon
- 5xxx Magnesium
- 6xxx Magnesium and Silicon
- 7xxx Zinc
- 8xxx Other Elements
- 9xxx Unused Series

99% Pure Aluminum

In the 1xxx group for aluminum of 99.00% purity and greater, the last two of the four digits in the designation indicate the minimum aluminum percentage. These digits are the same as the two digits to the right of the decimal point in the minimum aluminum percentage, when it is expressed to the nearest 0.01%.

The second digit in the aluminum designation indicates modifications in impurity limits. If the second digit in the designation is zero, it indicates that there is no special control on individual impurities: while integers 1 through 9, which are assigned consecutively as needed, indicate special control of one or more individual impurities. Thus, 1030 indicates 99.30% aluminum, without special control on individual impurities. 1130, 1230, 1330, etc. indicate the same percentage with special control on one, or more, impurities.

Aluminum Alloys

In the 2xxx through 8xxx alloy groups, the last two of the four digits in the designation have no special significance, but serve only to identify the different alloys in the group. Generally these digits are the same as those formerly used to designate the same alloy. Thus, 2014 was formerly 14S, 3003 was 3S, and 7075 was 7S. For new alloys these last two digits are assigned consecutively beginning with xx01.

The second digit in the alloy designation indicates alloy modifications. If the second digit in the designation is zero, it indicates the original alloy; while integers 1 through 9, which are assigned consecutively, indicate alloy modifications. In the former system, letters were used to designate alloy modifications. These were assigned consecutively beginning with A. Thus 17S is now 2017 and A17S is 2117, 18S is 2018 and B18S is 2218.

Temper Designation System

This designation follows the alloy number and is expressed by a letter, and one or more digits. The letter indicates a process which significantly influences the product's final form. The first digit following the letter indicates the specific operations that were used to produce the product.

Letter Designations

F. As Fabricated - Applies to the products of shaping processes in which no special control over thermal conditions, or strain hardening (rolling) is employed. For wrought products there are no mechanical property limits.

O. Annealed - Metal is made softer by heat treating. This enlarges the grain and reduces the tensile strength.

H. Strain Hardened - Metal is rolled to achieve specific tensile strength and yield properties.

T. Thermally Treated - To produce stable tempers other than F, O, or H.

Numerical Designations

H1 Indicates the metal was rolled to achieve a specific tensile range.

H2 Metal was rolled past the desired tensile strength, and then partially annealed back to the correct tensile and yield specifications. The benefit is a uniform grain structure.

H3 Applies to products which are strain hardened, and whose mechanical properties are stabilized either by a low temperature thermal treatment, or as a result of heat introduced during fabrication. Stabilization usually improves ductility. This designation is applicable to those alloys which, unless stabilized, gradually age soften at room temperature.

T3 Solution heat treated and then cold worked.

- T4 Solution heat treated.
- T6 Solution heat treated and then artificially aged.
- T8 Solution heat treated, cold worked, and artificially aged.

Temper Designations

The digit following the H1, H2, or H3 indicates the degree of strain hardening or the corresponding tensile strength.

The hardest commercial temper is designated by the numeral 8. For sheet having strength midway between that of the fully annealed temper (designated by the numeral "0")) and that of the hardest temper, the numeral 4 is used. The numeral 2 indicates tensile strength midway between 0 and 4 and 6 midway between 4 and 8 in tensile strength. For example, 3003-H14 is the designation for sheet having a tensile strength halfway between that of the soft and the hardest commercial tempers, produced by cold rolling to final dimensions after an intermediate processing anneal. 3003H24 has the same tensile strength as 3003-H14 but is produced by partial annealing from a harder temper. 3004H34 has been cold worked to produce the strength intermediate between the hard and the soft tempers, and then stabilized.

In the 1100, 3000, and 5000 series alloys, tempers can be produced by strain hardening. This is ordinarily accomplished by the introduction of an annealing operation at the proper point in the cold working process, so the amount of reduction after annealing is just sufficient to impart the degree of strain hardening required to produce the desired temper. This method of producing strain-hardened tempers is designated by the symbol "H1". Material having the same tensile strength may be produced by omitting the annealing operation or placing it earlier in the process of cold working so as to produce a harder temper than would be required for complete annealing. To indicate this method, the symbol "H2" is used.

Each of these methods has advantages for particular uses, although for most purposes both are equally suitable. "H1" material is better suited for deep drawing and stamping operations, but "H2" can be bent over a smaller radius and formed more severely. "H2" will tend to have brighter surface finish, but is less desirable for the application of anodic oxide finishes.

Alloys 3004, 5050, and 5052, on standing at room temperature after strain hardening, gradually decrease in yield strength, and increase in elongation with no substantial change in tensile strength, until finally a stable condition is reached. This can be accelerated at elevated temperatures, and the same result accomplished in a few hours so it is possible to supply intermediate and hard tempers without any further change in properties on standing at room temperatures. Sheet strain hardened and stabilized material is designated as "H3".

ANODIZED ALUMINUM

In the nameplate industry, anodized aluminum is used for many products that require special finishes and high durability. The purpose of this section is to help identify those finishes and to define specifications. Understanding this information can reduce scrap from incorrectly specified metal or rejections, improve production, and provide a better finished product.

When specifying an anodized product, be sure the specifications have a defined alloy. The anodic coating thickness, surface finish and color will vary depending on the alloy type. This is due to alloying elements such as copper, manganese, and silicon in the aluminum. For foils and light gauges, the most commonly used alloy is 1145, and in gauges above .008" (.20mm) it is 1100 or 5005. Other alloys such as 2024, 5052 and 6061 are used for engraving and other special applications.

In addition to alloy and temper specifications, it is important to know the depth of coating. The anodic film thickness is measured by the depth of the pores in the metal. Standard thicknesses for aluminum are as follows:

End Use	Thickness	Aluminum Association Designation
Flash	.00008"	A-21
Interior #1 & 2	.0001" to .0002"	A-22
Exterior #1	.0002" to .0003"	A-23
Exterior #2	.0003" to .0004"	A-23
Exterior #3	.0004" to .0007"	A-31 A-32 A-33

Specific service and appearance requirements of the part dictate the anodic film thickness. Average figures for film thicknesses for various applications are as follows:

- Decorative anodizing .00012" (.003mm)
- Appliance parts .0002"(.005mm)
- Automotive parts .0003"(.008mm)
- Exterior architectural .0004"(.010mm)

The end uses and anodic thicknesses indicated above are guidelines that can help with specifications. Thicknesses for photosensitive anodized aluminum are covered under GGP 455B, and are at the high end of the above range.

FINISHES

Metal in sheet or coil form can be specified with mechanical finishes that enhance its appearance. Mechanical finishes are applied prior to anodizing and are listed below:

Mechanical Finishes

Mechanical finishes are:

- Scratch brush
- Directional brush
- Bright

- Embossed
- Polished
- Butler brush
- Mill finish
- Matte finish (for low reflectivity and bar code materials)

Scratch brush finishes are used in gauges between .003" (.076mm) and .008" (.2mm) and offer a matte look for nameplates when a soft appearance is important to the finished product.

In addition to mechanical finishes, chemical finishes may be applied during the anodizing process. These finishes enhance the product to allow printing, etching, and other processing by the manufacturer.

Listed below are the finishes that may be specified.

Chemical finishes are:

- Color anodizing (i.e., black, blue, red)
- Clear anodizing
- Clear unsealed anodizing
- Matte

If colored material is being used outside and is subject to sunlight and fading, specify that it be UV (ultra violet) stabilized, in order to improve quality. Black, gold and clear will resist fading better than other colors.

In printing applications, some manufacturers will use a clear unsealed finish. This permits special colored dyes to flow into the anodic pores and later to be sealed.

Please refer to Government Specifications Section regarding specifications for Anodic Coatings on Aluminum.

II.2 STAINLESS STEEL

The purpose of this section is to identify and define the specifications that are important for nameplate applications on stainless steel sheet and strip.

ALLOY IDENTIFICATION AND COMPOSITION

Stainless steel alloys are identified most commonly by AISI (American Iron and Steel Institute) numbers. The AISI specifies the limits of chemical composition for the standard types of stainless steels. Type or chemistry alone do not necessarily assure the best properties for a given application. Many applications require special properties for end use such as a particular finish, hardness, or ductility. Nameplates generally require special finish conditions.

The alloys most commonly used in the nameplate industry are types 302, 304 and 430. The nominal chemical compositions and physical properties are listed at the end

of this section. The 300 series has excellent corrosion resistance to most types of atmospheric corrosion, and can be readily polished to high finish luster or brushed to various satin tones. The 400 series steels are suitable for interior applications and bright trim, since they do not resist corrosion as well as the 300 series.

FINISHES

There is some confusion regarding the finish designations for stainless steels. Standard finishes are defined by AISI and ASTM (American Society for Testing Materials) using the same designation system.

Questions arise from the general description given in these specifications, which do not account for the fact that equipment capabilities will vary among producers. A 2-B finish, for example, may vary in reflectivity and roughness from one vendor to another. To avoid purchasing material with an inappropriate finish, rely on purchasing specifications and obtain samples whenever possible. The finishes most commonly used for nameplate applications are:

- 2-B Cold rolled, bright finish.
- 2-BA Cold rolled, bright finish annealed in a controlled atmosphere furnace.
- No. 4 General purpose polish finish, one or both sides.
- No. 6 Dull satin finish, brushed one or both sides.

If surface roughness is critical, the topography of the surface (not to be confused with reflectivity) should be defined to the vendor. The surface roughness is determined by the grind of the work rolls used in the rolling mill. It is measured by RMS (Root Mean Squared) readings, performed with a profilometer. Typical mill finish 2-B, has a 5 - 12 RMS. A low RMS does not necessarily designate a highly reflective surface, although generally the more reflective the strip, the smoother the surface. When reflectivity is of prime importance, obtain a representative sample to insure it meets the brightness criteria. If smoothness is the main objective, consult with your vendor to quantify the RMS of the product to be supplied. This information should be included in your purchase definition.

The following stainless steel sheet finishes are from ASTM A-480. A sheet is defined as being less than 3/16" (4.76 mm) thick, and more than 24" (610 mm) long.

The types of finishes available on sheet products are:

- No. 1 Finish - Hot-rolled, annealed and descaled.
- No. 2 D Finish - Cold-rolled, dull finish.
- No. 2 B Finish - Cold-rolled, bright finish.
- No. 2 BA Finish - Bright Annealed finish: a bright cold-rolled finish retained by final annealing in a controlled atmosphere furnace.
- No. 3 Finish - Intermediate polished finish, one or both sides.
- No. 4 Finish - General purpose polished finish, one or both sides.
- No. 6 Finish - Dull satin finish, tamping brushed, one or both sides.
- No. 7 Finish - High luster finish.
- No. 8 Finish - Mirror finish.

Explanation Of Finishes

No. 1 - Produced on hand sheet mills by hot rolling to specified thicknesses followed by annealing and descaling. Generally used in industrial applications such as for heat and corrosion resistance, where smoothness of finish is not particularly important.

No. 2 D - Produced on either hand sheet mills, or continuous mills by cold rolling to the specified thickness, annealing and descaling. The dull finish may result from the descaling, or pickling operation, or may be developed by a final light cold-rolled pass on dull rolls. The dull finish is favorable for retaining lubricants on the surface in deep drawing operations. This finish is generally used in forming deep drawn articles that may be polished after fabrication.

No. 2 B - Commonly produced the same as 2D except that the annealed and descaled sheet receives a final light cold-rolled pass on polished rolls. This is a general purpose cold-rolled finish. It is commonly used for all but exceptionally difficult deep drawing applications. This finish is more readily polished than No. 1 or No. 2D finishes.

No. 2 B A - Bright Annealed finish is a bright, cold-rolled, highly reflective finish retained by final annealing in a controlled atmosphere furnace. The purpose of the atmosphere is to prevent scaling, or oxidation during annealing. The atmosphere is usually comprised of either dry hydrogen or a mixture of dry hydrogen and nitrogen (sometimes known as dissociated ammonia).

No. 3 - For use as a finish-polished surface, or as a semifinished-polished surface when it is required to receive subsequent finishing operations following fabrication. Where sheet or articles will not be subjected to additional finishing or polishing operations, No. 4 finish is recommended.

No. 4 - Widely used for restaurant equipment, kitchen equipment, store fronts, dairy equipment, etc. Following initial grinding with coarser abrasives, sheets are generally finished last with approximately 120 to 150 grit abrasives.

No. 6 - Has a lower reflectivity than No. 4 finish. It is produced by Tampico brushing No. 4 finish sheets in a medium of abrasive and oil. It is used for architectural applications and ornamentation where high luster is undesirable; it is also used effectively to contrast with brighter finishes.

No. 7 - Has a high degree of reflectivity. It is produced by buffing a finely ground surface, but the grit lines are not removed. It is chiefly used for architectural or ornamental purposes.

No. 8 - The most reflective finish that is commonly produced. It is obtained by polishing with successively finer abrasives and buffing extensively with very fine buffing rouges. The surface is essentially free of grit lines from preliminary grinding operations. This finish is most widely used for press plates, as well as for small mirrors and reflectors.

For mirror bright finishes, it is advisable to specify "paper interleave" to minimize surface scratching and scuffing in transit.

MECHANICAL AND PHYSICAL SPECIFICATIONS

To insure full compliance with specified requirements, it is advisable to include gauge, width, length and/or coil size and temper in addition to alloy and finish.

The following guidelines are applicable to each of the following areas:

Gauge

Generally specified in fractions of an inch, decimal, or metric equivalent, i.e. .018" or .46 mm., the standard industry gauge tolerance is plus or minus 5% of the specified gauge. If a tighter tolerance is needed it must be specified. In some instances, closer than commercial tolerance will incur an additional close gauge charge.

NOTE: It is advisable to avoid "gauge numbers" in specifying thickness. There are several "gauge" reference charts that may be confused with your actual needs.

Width

Slit width should also be specified in inches, or nearest decimal, or metric equivalent. Slit tolerances are typically plus or minus .005" to .015" (.13 - .38 mm) depending on width. Closer than commercial tolerance needs to be designated. This should be reviewed with your supplier.

Length

Nominal cut to length size should be designated in inches, decimal, or metric equivalent. Typical cut to length tolerance is plus or minus .062" to .250" (1.57 - 6.35 mm) depending on length of sheet. The tolerance should always be indicated. If a minimum length is critical, all tolerances should be specified to the plus side, with zero on the minus side.

Coil Size

The inside and outside coil diameter with minimum and maximum requirements should be specified. Also, maximum weight per coil, if there are handling limitations.

Temper

Standard tempers are achieved by cold work (rolling) or annealing (softening). In annealed products, finer grain size generally improves polishing and buffing response. Stainless grain size is designated by ASTM grain reference scales. The smaller the number, the larger the grain size. ASTM 6 - 9 grain is generally used in annealed stainless nameplate applications. If a specified rolled temper is required, it is advisable to include a tensile strength range.

Passivation Finish

During certain types of stainless processing, small particles of steel become embedded in the surface and may later become rust spots. Passivating the surface will remove these particles, and increase surface oxide thickness. This is done by immersion in 10 - 20% hot nitric acid. This treatment will discolor and mildly etch the stainless steel surface.

Often, as a matter of practice, passivation of stainless nameplates or panels is called-out. This passivation will damage the finish. Passivation is done after all other work, and therefore, the finish must stay in its discolored and etched state as a finished product.

In the manufacture of stainless nameplates, holes usually are punched, not drilled; finishes are buffed with rouge, or sanded with certain grits so the possibility of embedding particles of iron from these operations is negligible.

If, for some reason, passivation is necessary, then one should keep in mind that the finished article will be badly discolored and unattractive.

Government Specifications For Stainless Steels

Type 302

Federal QQ-S-766C

Military MIL-S-5059C

Type 304

Federal QQ-S-766C

Type 430

Federal QQ-S-766C

SUMMARY OF STAINLESS STEELS PROPERTIES

The specification requirements as stated above are suggested to define the parameters of your material requirements. The intent is to define accepted industry standards as they apply to nameplate users. Specific and accurate specifications will insure a quality end product.

	Austenitic Stainless Steel (Non-Magnetic)		Ferritic Stainless
	(Magnetic)		
Alloy No. or Type:	302	304	430
Nominal Composition:			
Carbon	.15.08	.12	
Chromium	18.50	18.50	16 00
Nickel	9.009.00	—	

Manganese	2 max	2 max	1 max
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Tensile Strength x 1000 PSI:

Annealed	95-110	70-80	
1/8 Hard	–	95-100	
1/4 Hard	125-150	125 min	
1/2 Hard	150-175		
3/6 Hard	175-195		
Full Hard	185-225		
			135 min

II.3 BRASS

The beauty and durability of brass are difficult to duplicate with any other metal. It may be buffed to a gold-like appearance, or may be given a distinctive brushed or satin finish. The matte finish that results from etching provides an interesting contrast, or the etched areas may be enamel-filled in a variety of colors.

It is standard practice to protect all brass surfaces with a clear coating to prevent tarnishing, or weathering discoloration. Brass plates may also be chrome plated for additional protection.

Brass is an alloy of only two metals -- copper and zinc. Thus, a simple rule may be used to determine the alloy content. If the CDA (Copper Development Association) designation is known, divide the last two digits by two, and the result will be the zinc content. The balance will be copper. For example, CDA 220: 20 divided by 2 equals 10; the zinc content is 10%, the balance of 90% is copper, the alloy is 90/10 brass. This should help to readily specify the brass family. NOTE: This formula does not apply to other copper alloys.

Six basic requirements are necessary for establishing brass specifications as follows:

1. Gauge, including tolerance
2. Width, including tolerance
3. Temper designator
4. Alloy type
5. Coil size or cut-to-length dimensions
6. Finish

While considering the above requirements, it is important to understand commercial industry tolerances that are available without additional cost.

GAUGE

The industry standard for gauge tolerance is plus or minus 10%; however, material is available at half commercial tolerance, or plus or minus 5%, without incurring additional cost. This results in much flatter parts because tighter rolling tolerances at

the mill help to increase flatness. If flatness is critical, it should be specified in fractions of an inch, based on width and length, as measured by using a dial indicator or feeler gauge.

WIDTH

Width should be specified with an industry tolerance of $\pm.005$ (.13mm).

TEMPER DESIGNATORS

1. Annealed
2. 1/4 hard
3. 1/2 hard
4. 3/4 hard
5. Full hard
6. Extra Hard
7. Spring
8. Extra spring
9. Super spring

Each of these designators has a corresponding tensile and yield strength which is expressed in pounds x 1000 per square inch of cross-sectional area, and should be used in all material specifications.

ALLOY TYPE

Three types of brass are commonly used in the nameplate industry:

70/30 Brass - This alloy is known as "cartridge brass" or CDA260. This is the most widely used nameplate brass.

85/15 Brass - It is also known as "red brass," or CDA230. As the copper content increases, the alloy becomes more reddish in appearance and is commonly used for trophies and plaques.

90/10 Brass - This alloy is known as "commercial bronze," or CDA 220 and may not always be available as a stock item.

Government Specifications are as follows:

CDA260 (70/30) - QQB-G13C

Composition 2

CDA230 (85/15) - QQB-G13C

Composition 4

CDA220 (90/10) - ASTM B36 Alloy 2

COIL SIZE OR CUT-TO- LENGTH DIMENSION

If sheets are purchased cut-to-length, dimensions should be specified. If coils are purchased, coil width, and total weight of material required can be used to determine coil size, with the aid of a coil calculator.

FINISH

Finishes on copper alloys relate to the specifications established for the end product. There are basically four finishes to specify:

1. C finish - this is a commercial finish. It may have scratches, oil, and a dull surface.
2. B finish - the surface does not have any scratches, dents, or imperfections. It may be interleaved with paper if required, at additional cost.
3. Polishing and plating quality - the surface is free of dents, scratches, and imperfections. It has a high luster capable of being buffed or polished.
4. Degreased – the metal is processed through a solvent wash to remove oil from the surface.

European material, in some instances, has a brighter finish than American material. This is due to rolling techniques employed by the Europeans. They grind their work rolls to a finer surface finish, and therefore the rolls actually burnish the surface and create a high luster. For applications where polishing and plating quality is needed to achieve high reflectivity, the German product is excellent.

Photoengraved Zinc

Features	Benefits
Durable	Suitable for use in environments with abrasion and abusive use.
Deeply etched image	Zinc can be deep etched with no undercutting of the image. This results in a more pronounced relief and a richer image. In addition, this deep image will remain even after any paint wears away.
Readily machined and formed	Zinc has excellent machining qualities and formability

Surface Finishes	Photoengraved zinc is available in a ground and brushed surfaces. Zinc may also be polished or electroplated with a variety of finishes
Accepts Paints & Inks	Can be painted or printed using many common graphic production techniques.
Heat Resistant	Can withstand high temperatures near its melting point of 419°C. The coefficient of linear thermal expansion of zinc is $30.2 / K^{-1} \times 10^{-6}$
Available in a variety of thicknesses	From 0.027" to 0.275"

Drawbacks	Relatively expensive. Easily corrodes in wet or humid environments if the protective topcoat is compromised. Paints and inks subject to abrasion and fading. Heavy parts may require mechanical fastening.
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Typical Applications:

- Industrial nameplates and logo plates
- Serial and data plates
- Equipment front panels, instruction plates, and other man-machine interfaces
- Decorative and durable gage bezels and escutcheon plates
- ADA compliant signage and elevator control panels

Photoengraving Zinc

Alloy

Element	%
Aluminium	0.02 – 0.15

Magnesium	0.02 – 0.15
Total Heavy Metals	<0.08
Zinc	Balance

Hardness VPN 50 (20Kg)

Size & Thickness Tolerances

	Gauge	Width	Length
Below 3mm	± 0.06mm	+ 3mm	+ 5mm
Above 3mm	± 0.07mm	+ 3mm	+ 5mm

Flatness

Variation of no more than 2.5mm over a 1000mm length

Physical Properties of Zinc

Atomic number	30
Atomic weight	65.39
Group in periodic table	12
Period in periodic table	4
Block in periodic table	d-block
CAS registry ID	7440-66-6
Standard state	solid at 298 K , distorted hexagonal close-packed structure
Colour	bluish pale grey
Density of solid [/ kg m^{-3}]	7140
Molar volume [/ cm^3]	9.16
Velocity of sound [/ m s^{-1}]	3700
Young's modulus [/ GPa]	108
Rigidity modulus [/ GPa]	43
Bulk modulus [/ GPa]	70

Poisson's ratio [no units]	0.25
Mineral hardness [no units]	2.5
Brinell hardness [/ MN m^{-2}]	412
Vickers hardness [/ MN m^{-2}]	no data
Electrical resistivity [/ $10^{-8} \Omega \text{ m}$; or $\mu\Omega$ cm]	5.9
Reflectivity [%]	80
Refractive index [no units]	1.002050
Melting point [K]	692.68 [or 419.53 °C (787.15 °F)]
Boiling point [K]	1180K (907 °C ,1665 °F) (liquid range 487.32 K)
Critical temperature [K]	no data
Superconduction temperature [K]	0.85 [or -272.3 °C (-458.1 °F)]
Thermal conductivity [/ $\text{W m}^{-1} \text{ K}^{-1}$]	120
Coefficient of linear thermal expansion [/ $\text{K}^{-1} \times 10^{-6}$] = length x temp change x coefficient	30.2 (The coefficient of linear thermal expansion is the ratio of the change in length per degree K to the length at 273 K.)
Enthalpy of fusion [/ kJ mol^{-1}]	7.35
Enthalpy of vaporisation [/ kJ mol^{-1}]	119
Enthalpy of atomisation [/ kJ mol^{-1}]	131

II.4 ETCHED NAMEPLATES

Etching is an old art form, having been used by artisans for centuries. An acid resistant material, or resist, is applied selectively to the non-etched areas, while the areas to be etched are left unprotected. The part is then subjected to a chemical solution that dissolves, or etches, the unprotected areas, resulting in two distinct surface levels. After etching, the part is cleaned and the resist removed. Thus, a two-dimensional flat surface is transformed into a three-dimensional, bi-level surface.

Etched nameplates are specified where a durable, long-lasting plate is required. They are used to advantage on products exposed to the elements and to sunlight, in corrosive or abrasive industrial environments, in marine applications, for extremes of temperature, or in applications where vandalism may be a problem. Markings produced by etching are virtually indestructible, and are as permanent as the substrate itself. Legibility is excellent, even after years of use and exposure. Metallic luster provides added appeal.

The etching process is quite versatile. It can be used, with or without paint fill, to produce an attractive product, or it may be used in combination with other processes; including anodizing, screen printing, lithographing, plating, or oxidizing, to provide additional colors, or a special appearance. Depth of pattern can be controlled within the limitations imposed by copy. Images may be either positive or negative, depending on the desired result.

METAL PREPARATION

Aluminum, stainless steel and brass are the most popular etched nameplate metals. Please refer to the discussion of each of these metals earlier in this section for the specific characteristics of each type. Metals may be purchased in sheets or coils, depending upon processing equipment available. If processed in sheet form, a number of smaller identical parts are usually arranged together on "flats" to facilitate handling, and to take advantage of processing economies. Larger panels, requiring special surface finishes and fabrication, are usually processed one at a time.

Metals are supplied in a variety of standard mill finishes, ranging from brite to brushed or matte. Most nameplate suppliers have metal finishing capabilities, and can produce special effects, at additional cost, when required. Type of surface finish should be specified at the time of quotation in order to avoid any misunderstanding.

Metals may be purchased with paper or plastic inter- leaving for surface protection. If protective oil is on the surface however, the material must be degreased prior to further processing.

PRINTING

Acid resistant materials may be selectively applied to metal sheets and plates by screen printing, lithography, and photography. Commercially available resists, inks, or emulsions may be used.

Screen printing is the most common method of resist application, since it is the most versatile, utilizes standard screen printing methods and equipment, deposits a heavier, more acid- resistant image on the substrate material, and allows for a deeper etch. Screened resists produce very acceptable detail for most applications, but finer detail may be obtained by other methods. Lithographed resists are thinner, and are generally used for finer detail and lighter depths of etching. Photographic resists provide the best definition of copy. Several types of commercially available, presensitized metallic and plastic plates are on the market for those who do not wish to do their own sensitizing. Photographic resists are more expensive than the other types.

After printing, the acid-resistant characteristics of most resists may be enhanced by baking. The temperature and time of baking depend on the type of substrate material, formulation of resist, type of etchant, and depth of etch required.

ETCHING

The two most common methods of etching are spray etching and immersion etching. Spray etching is accomplished in commercially available etching machines, which are specially constructed of acid-resistant material. The work pieces are placed on a conveyor system and pass through the etch chamber, where oscillating spray nozzles direct jets of etchant toward the top or bottom, (or both), of the work pieces. The etchant formulation depends on the type of metal being etched. Precise control is achieved by regulating the speed of the conveyor, composition of acid, intensity of spray and temperature of the etchant. When the desired depth has been achieved, the work pieces exit the etch chamber, where they are then rinsed and dried.

Immersion etching is accomplished in stationary etching tanks. Work pieces are lowered into the tanks on racks and etched for a predetermined period of time, then cleaned, rinsed, and dried. An etching "line" normally consists of preparatory solutions, etchants, rinses and cleaners, similar to a plating line. Some of the tanks may be heated or cooled, the solutions may be agitated, and in some cases, electrochemistry may be utilized to enhance the etching action.

When metals are etched, the various component elements are dissolved in chemical solutions. The resulting etched surface may be quite smooth, or it may have a rougher, matte texture. Major factors determining the relative roughness or smoothness of an etched surface are: type of metal and alloy composition, grain size and/or hardness, formulation of etching solution. and temperature of etchant.

Standard normal depth of etch for most etched and filled plates is .0015 to .003 (.038 to .076 mm). For special applications, the depth may be considerably more. Nonstandard requirements should be specified at the time of quotation.

The etching process generates multiple waste streams that must be handled in accordance with federal, state, and local regulations. Please ensure that your nameplate supplier is in full compliance in order to protect our environment.

PAINTING & FINISHING

Most etched plates are painted in the etched areas with baking enamels, or other suitable types of paint. Painting is normally accomplished by spraying while the resist is still on the part. The resist serves as a paint mask. Some types of paints may be applied by printing in registration. After the paint is baked or cured, the resist is removed, leaving the original metal surface raised, and the etched, lower surface filled with paint. Painting provides a contrast for the natural metallic surface, resulting in a very attractive finished product. In some cases, more than one color may be applied to different areas such as logos, or the parts may be antiqued, plated, anodized, or reprinted with additional copy to enhance the appearance.

COST

Etched plates generally cost more than those that are not etched, because of the extra equipment, labor, and processing steps required. Most users feel, however, that the

additional expense is warranted, when the product must meet one or more of the special requirements listed earlier.

For a given size and gauge, stainless steel and brass plates will be more expensive than aluminum. Anodized aluminum will be more expensive than regular aluminum. Additional paint colors, or other special processing will naturally cost more. Round corners, mounting holes, adhesive backing, and protective masking will add to the cost. Most suppliers have a number of standard size dies, but if a special size or shape is required, there may be an additional tooling charge. Please be sure that all specifications are known before a job is quoted.

Your nameplate supplier should be consulted during the planning stages in order to achieve the desired results at the most reasonable cost.

II.5 EMBOSSED, STAMPED AND ENGRAVED NAMEPLATES

Some nameplate applications require character relief in excess of that normally attainable by other methods such as etching. This additional depth may be attained by embossing, stamping or engraving.

EMBOSSING - DEBOSSING

Embossing is the process used to raise a pattern of copy above an original (normal) surface by the use of matched male and female dies. Its opposite, debossing, is used to depress copy below the surface. Metals suitable for embossing include aluminum, brass and steel. In general, metals which have been annealed are more readily embossed. Material thickness can vary from foils up to 1/16" (1.6 mm) and more. Several important factors should be considered when designing embossed nameplates:

- Relief of the characters (height and depth) should not exceed the thickness of material.
- Character legibility depends on copy height and thickness of material.
- Heavy gauge metals and large embossed/debossed areas may require larger press tonnages.

Blind embossing is the term used to describe embossing that has no initial color contrast between the copy and background areas. Blind embossed plates may be given color contrast after embossing to enhance appearance and legibility. Embossing may be combined with lithography, or screen printing to produce decorative nameplates, as well as to provide good color contrast. The fabrication of decorative, embossed nameplates requires precise registration, integrating character height and material thickness.

Embossed letters and digits may be produced with standard stock male and female dies, if the type style is not critical. Male and female etched dies may be used for short runs on light gauge aluminum while precisely engraved, hardened steel dies are used

for intricate work on heavier gauges, and for long runs. Consulting with the nameplate supplier during design may help limit tooling costs

STAMPING OR INDENTED

Stamping is the process whereby hardened steel type, or dies, are pressed into a metal plate from one side only, as opposed to embossing, which is done from both sides. Sharp faced type is usually used to stamp data plates and serial numbered plates. Flat face type is commonly used on tags where the copy is to be filled with color. Dog tags, tool checks and inventory tags are typical types of stamped tags.

SERIAL NUMBERING

Variable copy, such as consecutive serial numbering, is usually added to a nameplate containing other permanent copy as a separate step. Some serializing applications require embossing but most are stamped. When designing a nameplate with variable copy, space considerations are very important since they are serialized in a separate operation. Allow a minimum of 1/32" (.8mm) top and bottom margin and 1/16" (1.6mm) at the left and right ends. A reference list follows for character spacing of some common sized numbering heads. Actual lengths may vary with numbering head manufacturer; please contact your supplier if spacing is critical.

Standard (Most Common) Height	Average Width Digit and Space
Sharp Face Gothic	
Flat Face Roman Style	
1/16" (1.6mm)	.085" (2.2mm)
3/32" (2.4mm)	.125" (3.2mm)
1/8" (3.2mm)	.140" (3.6mm)
3/16" (4.8mm)	.188" (4.8mm)
1/4" (6.4mm)	.200" (5.1mm)
3/16" (4.8mm)	.175" (4.4mm)
1/4" (6.4mm)	.200" (5.1mm)
5/16" (7.9mm)	.245" (6.2mm)
7/16" (11.1mm)	.345" (8.8mm)
1/8" (3.2mm)	.170" (4.3mm)
3/16" (4.8mm)	.215" (5.5mm)
1/4" (6.4mm)	.250" (6.4mm)
5/16" (7.9mm)	.250" (6.4mm)

ENGRAVING

Engraving is a mechanical process in which copy or a pattern is cut into metal or plastic. A stylus follows an oversize master pattern on a pantograph machine, while a rotating cutting tool simultaneously cuts the same copy into the desired part. Engraving is ideal for small quantities and may be used where sunken lettering must be applied to finished parts. The advantages are low setup costs and quick turn around times.

Depth of engraving is a function of the character width or stroke, and of the material being engraved. Many stock letter styles are available; special logos, lettering, or patterns may be created at an additional charge. Because the letters are cut with a rotating tool, all letters have a round end with a minimum diameter of 3/32" (2.4mm). Computer aided engraving machines are now available that greatly increase productivity and accuracy.

Engraving is best accomplished on high temper brass or aluminum, and on two-color laminated heat-resistant plastics. Engraving through the top lamination of plastic exposes the core, providing a contrasting color. On metal plates, contrast is achieved by filling the engraved letters with an enamel paint.

II. 6 PHOTSENSITIVE NAMEPLATES

There are three main photosensitive nameplate processes: photo etching on metal, photographic printing on metal, and photosensitive printing on plastic. All three are suited to the manufacture of short-run nameplates and labels, signs, prototypes, or applications where there are many copy changes. Photosensitive methods are occasionally used for longer runs where their unique technical attributes are required.

Photosensitive nameplate materials are supplied by several manufacturers — along with the necessary processing equipment and chemicals. They are used by both nameplate manufacturers and large name-plate users who need in-plant nameplate making capabilities.

PHOTO ETCHED

The photo etch process is used with all common nameplate metals. Photosensitive anodized aluminum and stainless steel are stock items on the market.

In the photo etch process, a photo resist-coated sheet of metal is exposed to light through a film negative, the resist is selectively removed by developing, and the base metal is then etched to produce the name-plate copy. On anodized aluminum, this results in natural aluminum copy on a contrasting anodized background color. Photo etched stainless steel plates are frequently paint filled for color contrast.

Photo etched plates offer the quality "feel" of etched letters. They are durable and attractive. Photo etched plates are available in thicknesses from .003" to .125" (.07-3.2 mm), and in a range of colors and finishes. The photo etched process is specified generically as meeting Federal Specifications GG-P-455b, Type II.

PHOTOGRAPHIC

The photographic process is available in anodized aluminum only. A photographic silver compound impregnated sheet of aluminum is exposed to light through a film negative. The latent photographic image is then developed, fixed and sealed to produce black copy on an anodized background. The background may be natural or in a color, such as gold or red.

The resultant nameplate is the most durable of any produced in aluminum, because of the permanence of the silver image sealed into the anodized layer. Plates produced by the photographic process are capable of withstanding temperatures to 1,000° F and years of outdoor weathering and abrasion. The process is capable of reproducing fine line copy, halftones, and continuous tone photographs. The photographic process is specified generically as meeting Federal Specification GG-P-455b, Type I.

PHOTOSENSITIVE PLASTIC

The photosensitive plastic process is available in two configurations: surface printed and subsurface printed. The photosensitive layer is exposed to light through a film negative and is then developed chemically, or in hot water, depending upon the particular brand of photosensitive plastic. Plastic plates are available in a range of colors. Photosensitive plastics with subsurface copy require an additional lamination step. However, plates with subsurface copy may outlast metal in many environments.

II.7 APPLIANCE PANELS

Applications for metallic panels are most frequently found on microwave ovens, ranges, refrigerators, washers and dryers, auto instrument panels, electronic control devices, and television sets. The design function covers a very broad range from decorative to instructional or structural.

A decorative panel for television can be produced on .020" (.5mm) aluminum on which a three or four color pattern is applied by offset lithography. Lithography is used in order to obtain the half-tone detail of color shading that duplicates the color and grain detail of natural wood. The grain detail is reproduced photographically from a natural wood sample. Each color in the wood is matched with inks and applied separately to the metal substrate. This product may also be produced with perforated metal for use as a TV speaker grill. Panels of this type are usually attached by a laminated pressure sensitive adhesive or metal tabs which are blanked out of the metal substrate.

Panels on ranges, washers and dryers serve a structural purpose. The metal thickness should be .040" (1.0mm). These panels are up to 30 or 40 inches long (76-100 cm) and are designed to support switches, valves, clocks and timer devices. Holes for these devices are pierced with hardened steel tooling. The same tooling also contains the forming punches and dies where required. A panel of this type may need as many as four or five separate hardened steel blanking, piercing, and forming dies to produce the finished shape. As in most other metal nameplates, the decoration is applied prior to the die work by either offset, litho or screen printing. The surface finish on panels of this type must meet several very stringent specifications related to the durability of the product, including superior adhesion, abrasion resistance, and detergent resistance

II.8 DECORATIVE TRIM

The descriptive term “decorative trim” was coined by metal nameplate manufacturers to set apart a class of product that they considered more complicated than the average flat, one or two color, metal nameplate.

This class of product is usually found on small appliances, automotive instrument clusters, televisions, and electronics equipment.

The manufacturing operations require a broad range of skills and equipment to produce not only the variety of finishes, but also the high volume of product for OEM customers. The principal characteristics of decorative trim are: three or more colors, two or more metal finishes, and two or more hard tooling operations — all combined and applied to each part produced. This work is usually done in multiples on sheets 3 to 4 square feet in area.

A wide variety of metal finishes are available. Bright and brushed areas may be combined by selectively masking the bright base material with a screen printed resist; then brushing or circular spinning the unmasked area. The resist is then removed to develop the desired contrast in finish. A variety of mechanical and chemical finishes may be combined in a series of similar operations before printing to achieve the required designers’ appearance.

The printing operations may be multiple color applications, using either offset lithography, or screen printing, or both.

A clear, protective top coat over the decorated metal finish is normal for decorative trim, and there may be frequent requirements for two gloss levels on the final product. An example would be a semigloss woodgrain combined with a high gloss border.

Hard (Class A) tooling is always necessary for this type of product due to the essential dimensional accuracy of blanking and forming, and to the long runs usually required. Since all final mechanical operations are performed on the decorated metal sheets, an additional protective, strippable coating is applied prior to these punch press operations.

The accuracy of blanking requires very tight tolerance strip shearing; it is not unusual to find tolerances of ± 0.002 " (.05mm). Also, the blanking registration to colors can be ± 0.007 " (.18mm). Multiple die operations are common for decorative trim. After blanking, it is often necessary to form tabs, form edges all around, clinch edges, deboss panel areas, emboss characters or logos, or to diamond cut embossed characters and logos.

It is obvious from the above brief description that a large number of operations—as many as twenty or thirty—are performed on “decorative trim” parts. Consequently, this class of product will usually be higher in cost, and need longer than average lead time. The final product itself is usually a work of art and a compliment to the customer’s product.

II.9 BEZELS OR FRAMES FOR NAMEPLATES

There are 3 basic types of bezels used in the industry:

1. Zinc die-castings painted or plated for interior or exterior applications.
2. Molded plastics, painted or plated for interior or exterior applications.
3. Coined aluminum, painted or color-anodized for interior or exterior applications

Some of the advantages and characteristics of each are as follows:

Characteristic	Zinc Die Casting	Molded Plastic	Coined Aluminum
Intricate designs Permitted	yes	yes	yes
Trim dies needed	yes	no	yes
Finishing required before painting to remove parting line	yes	no	yes
Finishing required before plating	yes	no	yes
Preplate required	no	yes	no
Dimensional Stability	yes	no	yes
Thermal cycle Problems	no	yes	no
As produced, has stud limitations for fastening use	no	yes	yes
Good fastening strength on studs	yes	no	yes
Available in translucent colors without additional operation	no	no	yes
Requires material shrink factored into mold/die	yes	yes	no

construction

Various opaque base colors and gloss available without additional operations	no	yes	no
Significant cost reduction possible on high-volume parts with the addition of multiple-cavity tooling	yes	yes	no
Additional operations required for exterior use	yes	yes	no
Lends itself to top surface hot-stamping	no	yes	no
Lends itself to satin-finishing	no	no	yes

In general, almost all die cast zinc bezels are chrome plated, all aluminum bezels are anodized, and plastics are as-molded or chrome plated.

MOLDED PLASTIC AND DIE CAST ZINC PARTS, CHROME PLATED

Molding conditions as well as part design influence the durability of parts that are subsequently plated.. Good control of the melt, mold temperatures, fill times, moisture content (minimized by vented screw), gating, pressures, etc., are essential to molding a platable part. Fast fill and uncontrolled temperature of the melt, and the mold, will cause mold stresses resulting in plating and thermal cycle problems.. Uniform sections will minimize turbulence during molding, thereby minimizing stress in the part.. Radii of 0.060 inch (1.52mm) in all inside corners will facilitate material flow and reduce stresses (and also aid in solution drainage during plating).

Gating and ejector pin locations should be agreed-to and approved by the product design engineer, the manufacturing engineer, and the tool source. These should be located on nonsignificant surfaces to avoid stress resulting in corrosion, thermal cycle, and appearance problems.. Molder and plater should be same source if possible.

Die Cast Zinc

In addition to the normal dimensional and metallurgical details on part prints, supplemental data on specific product requirements may affect the basis of a die casting quotation. The following checklist provides a numbering system in which the lowest numbered description for each requirement can be met at the lowest production cost. It will be to the advantage of both the buyer and the die caster if such a checklist accompanies prints submitted for quotation.

- 1 most economic basis of production
- 2 involves additional work which may affect cost
- 3 additional work and special requirements which increase cost.

A. SURFACE CONDITION

1. Some residue and chips not objectionable.
2. Shop run - blown reasonably free of chips but not degreased.
3. Clean, dry and free of chips.

B. CAST SURFACE FINISH

1. Mechanical Grade - finish is not significant.
2. Painting Grade - some streaks and chill areas that can be covered with paint.
3. High Quality - for electroplating, anodizing or other decorative finishing.

C. FLASH REMOVAL Parting Line External Profile

1. No die trimming - break off gates and over flows and remove flash within .125".
2. Die trimmed - to within approx. .015" of die casting surface. (See ADCI Standard E- 10.)
3. Hand filed or polished - flush with die casting surface.

D. FLASH REMOVAL Cored Holes

1. Flash not removed.
2. Flash trimmed to within .010" of die casting surface.
3. Flash to be machined.

E. FLASH REMOVAL Ejector Pins

1. Not removed. (See ADCI Standard E-9.)
2. Crushed or flattened. (See ADCI Standard E-9.)
3. Removed from specific locations.

F. PRESSURE TIGHTNESS

1. No requirement.
2. Pressure tight to agreed upon PSI. Testing Medium
3. Other arrangements to be agreed upon.

G. FLATNESS

1. No requirement.
2. To tolerances shown in ADCI Standard E-5.
3. Critical - must hold all specified dimensions.

H. DIMENSIONS

1. Normal - (As per ADCI Standards.)
2. Semi -Critical - must hold certain specified dimensions. Others as per ADCI Standards.
3. Critical – must hold all specified dimensions.

I. CUSTOMER'S RECEIVING INSPECTION

1. No statistical Quality Control – no unusual inspection requirements.
2. Statistical Quality Control - AQL's over 2.5%.
3. Statistical Quality Control - shipment acceptable at AQL of _____ %.
(2 and 3 above, require details of inspection procedure, with major and minor defects agreed upon.)

J. PACKAGING

1. Not critical - bulk packed.
2. Layer packed - with separators.
3. Packed in cell type separators or individually wrapped.

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Spearlike Juts



Buildup on jut will rob corners from their share of electroplate. Crown the base and round off all corners.

Blind Holes



Blind holes must usually be exempted from minimum thickness requirements

Flanges



Large flanges with sharp inside angles should be avoided to minimize plating costs. Use a generous radius on inside of angles and taper the abutment.

Concave Recesses



Electroplatability is dependent upon dimensions.

The sketches above illustrate some configurations which can cause nonuniformity of plating thickness on both zinc or plastic.

For detailed information on design and plating of zinc and plastic bezels contact:

1) American Die Casting Institute, Inc.
2340 Des Plaines Avenue
Des Plaines, IL 60018

2) Zinc Institute, Inc.
292 Madison Avenue
New York, NY 10017

II.10 INSTRUMENT PANELS

Instrument panels are usually thought of as heavier gauge, fabricated panels that are self-supporting and used for mounting dials, switches, gauges, etc. They are normally made of the following materials:

Aluminum

Aluminum may be screen printed with natural or colored finishes, anodized in various colors, etched and filled, or photo-sensitive.

Stainless Steel and Brass

Stainless steel and brass tend to be used for decorative panels and architectural applications. These metals may be screen printed with natural and colored finishes, or etched and filled. Other specialized finishing methods are also available.

Plastics, Plastic/Metal Laminates

Plastics and plastic/metal laminates are available in clear or colors. They may be screen printed in several colors on the first or second surface. Advantages of this type of panel are a level of panel strength and rigidity that will support instruments, switches and assemblies. Such panels may be used as a structural part of a fabrication and their increased material thickness allows for countersinks, tapped holes, and studs to accommodate instrument requirements. and in many cases the elimination of assembling chassis cost.

Disadvantages of this type of panel are design parameters that must include allowances for panel mounting by way of screws, bolts and studs; also in most applications, adhesives alone are not recommended for fastening because of weight; and a higher unit cost than a chassis overlay.

Design and manufacturing parameters are:

Holes

For panel and hardware mounting, screw, bolt or rivet holes are most cost effective. Holes may be countersunk, tapped or counterbored.

Studs

Several types of studs are used as follows:

1. Self-clinching studs through face of panel which are cost effective and can be blended into face of panel through mechanical finishing, but will remain visible unless painted or overlaminated.
2. Concealed head studs where: studs are swaged into a blind hole on the back of the panel and not visible on the face of the panel, but higher in cost.
3. Welded/brazed studs which are higher in strength and more costly but worthwhile where anodizing may show discoloration around weldments.

Fabrication Techniques for Instrument Panels

Fabrication techniques for instrument panels are either numerically controlled or employ hard tooling.

In numerically controlled fabrication, the hole patterns are entered into an NC turret press for piercing. This process minimizes or eliminates tooling cost, and allows for flexibility in hole location and size revisions. It also produces close tolerance dimensions between hole centers, typically ± 0.005 " (.127mm)

Hard tooling for fabrication increases capital expense, and decreases piece price. It also reduces flexibility for revisions, and produces close tolerance dimensioning, typically less than ± 0.005 " (.127mm).

SECTION III: PLASTIC SUBSTRATES

The ever increasing requirements for product identification, changing demands for design “appeal,” and improved application techniques require manufacturers, customers, and suppliers to be familiar with non-metallic substrates.

This section provides a brief overview of many such substrates. New advances are made in the industry each year, creating new generations of products. Any list compiled here will be partial at best. You may obtain additional information suppliers and their technical guide books.

III.1 PLASTIC TYPES

ACETATE

Acetate is available in a variety of thicknesses, with a clear or matted finish. Acetate exhibits excellent clarity and heat resistance, but poor solvent, abrasion, and tear resistance. Therefore, it is often used as an indoor decal.

ACRYLIC

Acrylic is available in a clear or pigmented state. It is generally used for decals requiring resistance to prolonged exterior exposure, and in applications requiring destructibility.

POLYCARBONATE

At one time, polycarbonate products were offered in rigid sheet only. However, today the availability of films, starting at thicknesses of 1 mil, make this product one of the more versatile decal face stocks. Presently most applications involve clear or textured surface films, however, the industry is expanding their use with metallized and brushed (striation abraded) metallized versions. Polycarbonate exhibits excellent clarity, stability, printing, and die cutting characteristics with good solvent resistance.

POLYESTER

Polyester is one of the most versatile films for decal face stocks. Polyesters are available in a wide range of thicknesses, and in clear, matted, pigmented, metallized, brushed metallized, or transparent colors. Polyester films offer excellent clarity, stability, abrasion resistance, solvent resistance, printing, and die cutting characteristics with good exterior durability.

LAMINATES

Generally, laminates are comprised of two or more thicknesses of film tailored for embossability. These products are used for high quality custom embossed nameplates.

POLYETHYLENE

Polyethylene films are available in a variety of densities and thicknesses and in pigmented form or with limited clarity. Polyethylene films are generally used in applications where heat resistance and exterior durability are not required.

POLYPROPYLENE

Polypropylene is a versatile film available in clear or pigmented form in a variety of thicknesses. Polypropylene films offer good clarity, stability and abrasion resistance with excellent solvent and acid resistance but limited exterior durability.

POLYSTYRENE

“Styrene” films are generally available in pigmented form: however, some gauges are available in clear. These films exhibit good temperature resistance and solvent resistance, but poor outdoor durability. This film is generally used where stiffness or rigidity is required.

POLYVINYL FLUORIDE

These films offer superior UV resistance, solvent resistance, and the ultimate in stain resistance. Used for high quality, long term outdoor markings.

VINYL

Vinyl (polyvinyl chloride) is perhaps the most versatile of decal face stocks. Vinyl is available in a wide range of colors and thicknesses. These films are available in a number of formulations including cast, rigid, semi-rigid, and flexible. The formulation used depends upon the end application. Vinyl films are generally used for their weather resistance, conformity, color selection and durability.

Most of the plastic films previously listed above may be printed using one or more printing methods. Depending on the method used, special inks may be required. Top coatings have been developed by pressure sensitive film suppliers which enable a wider variety of methods and inks to be used in converting. Your film and ink supplier can be of assistance in selecting the proper products.

Film	Available Thickness	Clarity	Color Selection	Finish	Dimensional Stability	Outdoor Durability	Abrasion Resistance	Heat Resistance	Comments
Acetate	1.5-5mils	Excellent Window decals toy decals. Tamper evident seals	Check with Supplier	Gloss and	Good	Poor	Poor	Excellent	Limited colors available
Acrylic	2 mils	Hazy Exterior decals –	Clear or	Flat Finish	Good	Excellent	Good	Fair	Additional

	Some destructible applications		White						thickness and Colors available On custom basis	
Polycarbonate	1-10 mils+ Touchtone panels, keyboard faceplates, OEM decals	Excellent	Check with Supplier	Gloss ad Various Textures Metalized Brushed	Excellent	Poor	Poor	Excellent	Textured surfaces offer more abrasion resistance. Special abrasion resistant formulation available.	
Polyester window nameplates,	1-10 mils+ Clear films used decals, and as overlaminating films. Metalized films used for nameplates. emblems, OEM markings. White films used emblems, opaque window decals, etc.	Excellent	Clear White Metalized	Gloss ad Matte Hazy	Excellent	Good	Excellent	Excellent	Excellent solvent resistance	as
Polyethylene	3-10 mils+ Used in packaging bottling applications	Hazy	Clear, White Limited Colors	Flat & Glossy	Poor	Poor	Fair	Poor	Primary advantage to this film is cost and Conformity	In
Polypropylene interior	5-10 mils Pop labels, over laminating, film applications	Excellent	Clear & White	Glossy & Flat	Excellent	Poor	Good	Good	Excellent acid and solvent resistance	for
Polystyrene	2-10 mils Battery labels, pop displays	Excellent	Clear & White	Glossy & Flat	Good	Poor	Good	Good	Excellent chemical resistance	
Polyvinylfluoride	1-2 mils Long Term exterior markings	Hazy	Clear, White Limited Colors	Matte & Flat	Good	Excellent	Good	Good	Excellent chemical and stain resistance	
Vinyls (Cast)	2 mil Fleet markings. OEM markings. recreational vehicle and boat markings	Good	Wide selection of colors	Gloss & Flat	Excellent	Excellent	Good	Good	Conformability for applications over rivets and corrugations. Thermal die cuttable	
Vinyls (5 Year) Flexible Calendered	4 mil Long term exterior markings	Fair	Clear, White plus wide selection of colors	Gloss	Good	Excellent	Good	Fair	Thermal die cuttable Flat surface applications	

Vinyls Flexible Calendered	3-10 mils+ Fair Promotional decals, pop, bumper stickers, OEM decals	Clear, White plus wide selection of Colors	Medium Gloss and Flat	Good	Good	Good	Fair	Thermal die cutable
Vinyl Semi Rigid	3-10 mils+ Promotional decals, OEM decals, signage	White and limited colors	Flat and Medium Gloss	Good	Good	Good	Fair	Thermal die cutable

III.2 PANELS AND OVERLAYS

SUBSTRATE MATERIALS

On all substrates specified by the customer, the standard specifications of the substrate manufacturer should apply regarding the following:

- Thickness Tolerances
- Color Clarity
- Solvent Resistance
- Temperature Service Ranges
- UL or CSA Rating
- Dimensional Stability
- Weatherability or Durability

Within the manufacturer's specifications, substrates should be free of foreign substances, surface scratches, mars and blemishes that may affect the cosmetic appearance when using normal inspection criteria.

It should be the responsibility of the customer to specify a substrate that meets the physical, environmental and cosmetic needs of the finished part. It should be the responsibility of the supplier to consult with the customer and to aid in the selection of the appropriate material and to make every effort to notify the customer if there is reason to believe that the material will not meet the customers' specified requirements.

It should be the responsibility of the supplier to inspect incoming material before printing to insure that it conforms to the substrate manufacturer's specifications.

ADHESIVES

On all adhesives specified by the customer, the standard specifications of the adhesive manufacturer should apply regarding the following:

- Specific adhesion to substrate
- Thickness
- Irregularities or voids
- Solvent resistance
- Temperature service ranges
- Shelf life

- Service life

It should be the responsibility of the customer to specify an adhesive that meets the physical and environmental needs of the part. It should be the responsibility of the supplier to consult with the customer and to aid in the selection of the appropriate adhesive, and to make every effort to notify the customer if there is reason to believe that the adhesive will not meet the customer's specified requirements.

The supplier should not be responsible for failure of the specified adhesive to perform per the adhesive manufacturer's specifications.

Selective Adhesive

Adhesive that is selectively applied to the back of a part is a very common requirement. It is important for the customer to understand that this is a "hand apply" operation. As such, it may be difficult for any supplier to guarantee placement of adhesive to tolerances closer than $\pm.030$ " (.762mm). However, the supplier should guarantee to keep specified areas free from adhesive, within the stated tolerance.

VISUAL COLOR MATCHING

The persons inspecting color should have 20/20 (or corrected 20/20) vision and have unimpaired color perception. If wearing glasses, they should not contain any tint or be optic gray. A white smock should be worn when viewing color to prevent ambient color influences from clothing

Upon request, color-swatches made from matched ink are furnished to the customer regardless of the color system used (PMS, American Standard, Munsell, etc.). The approved color-swatches should be used by the customer and printer as controls.

Due to the variations that exist within the same color system, it is recommended that the customer furnish the supplier with control color samples matching whenever possible.

Color swatches furnished to the customer should be 2" x 3" (50.8 x 75.2mm) and should be printed on the same substrate to be used for the production run. All swatches submitted to the customer should be printed on the same substrate, with the same laminate or coating and, on the same side of clear films as the production part will be.

A Munsell N-8 neutral gray mask with two 3/8" (9.525mm) holes, 1/2" (12.7mm) apart should be used over the original and the prepared swatches to visually check colors.

Unless otherwise specified, all colors will be compared per American National Standards Institute PH2.45 1979, using a color inspection viewing booth with 5000 Kelvin illuminant at a 45 degree viewing angle, and using a Munsell N-8 neutral background.



Tips for Color Matching

- Never approve a first surface control color-swatch if printing is to be second surface.
- Never approve a control color-swatch on clear material if part is to have a first surface texture.
- Never approve a control color-swatch that is not on the substrate that will be used in the production of the part.
- Never view colors with tinted or optic gray lens in glasses.
- Make sure your color perception is perfect approximately one out of 100 men have impaired color perception - women do not suffer from this eye imperfection.

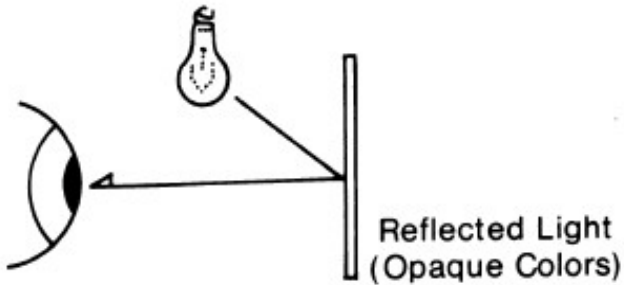
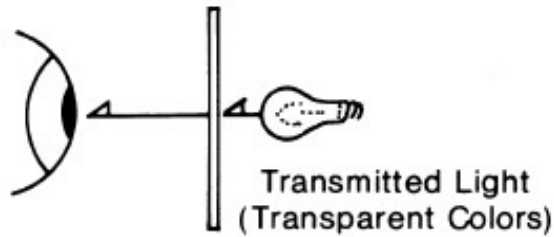
Always be aware of ambient color influences. (Walls, solar windows, clothing) Your PMS book may not be exactly the same as your supplier's. Always check color against original control color-swatch to prevent drift. Transparent colors should be viewed over the light source that will be used in the product.

TRANSPARENT COLORS

In industry today, there are a number of uses for transparent or translucent colors. A transparent color is optically clear and used for filters for backlit 7 segmented displays where you need the clarity to reduce blooming of the display. A translucent color is normally used for diffusing an indicator light or backlighting for printed graphics such as an instrument cluster that is backlit. Many keyboard overlay and front panel applications require transparent or translucent colors for LED's, seven-segmented display readouts, displays and indicator lights.

Transparent or translucent colors can also be "deadfronted" so that they are visible only when backlit.

Transparent colors are single pigmented inks or inks formulated with dyes instead of pigments. The pigment or dye determines the light transmitting capacity of the printed layer. Transparent or translucent colors are the result of a light source transmitted through the pigment or dye as opposed to being reflected off the pigment or dye.



In either case, the perceived color is a combined result of the color wavelengths of the light source being used with the printed ink. The perceived color will change dramatically when different light sources are used for illumination. It is critical to require the correct housing with the attached light source from the customer to match the color.

Deadfronts

In the front panel and keyboard overlay industry, there is a technique commonly called “deadfronting”. This is actually a transparent or translucent ink printed behind an open area in the front panel or overlay. The area may be a very small window reversed out for a LED indicator light or for a 7 segmented readout. The benefit of “deadfronting” an LED or readout display is that it will be visible only when backlit and only at times when you specifically want to see the display.

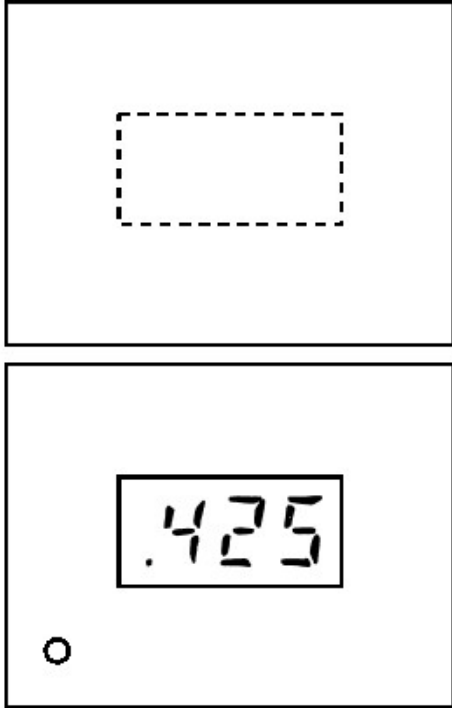
Deadfront Applications

There is a misunderstanding that deadfronts are always in a black reversed out area of a black background. This is not the case as deadfront can be achieved in any background color but not for all applications.

It is a fact that a black background with a black deadfront will give superior results for a segmented display for graphics. The reason being the black used for the deadfront is

a transparent color not a translucent color and you get a water clear result of the printed in.

Typical Deadfront Application



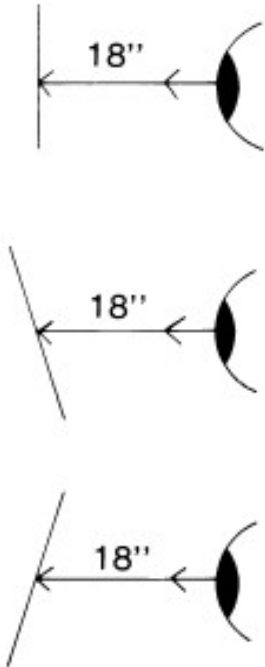
Ink Opacity

Non back-lit parts should be inspected by underlaying them with a 1/4" (6.35mm) grid pattern of .050" (1.27mm) black lines printed on a white background. No pattern (grid) will be visible in required opaque areas.

SELECTIVE TEXTURIZING

Upon request, the supplier will furnish the customer with samples of the texture to be used, and the finished product should visually match sample when viewed at a distance of 18" (45.7cm) without magnification.

Parts should be viewed straight on and rotated 30 degrees.



No discernible variation in texture or gloss of part should be acceptable when inspected per above.

EMBOSSING

Many keyboard applications require embossing the overlay in order to aid in tactile response, and for the operator to easily locate the keypad. In addition, embossing can be used for a styling effect on overlays and front panels.

Specifications

The key considerations to keep in mind when specifying embossing are type of material, embossing dimensions, and registration.

Material

Either polyester or polycarbonate overlays can be embossed. Due to the inherent characteristics of each, polycarbonate will emboss better and retain the emboss better through heat cycle testing. Polyester tends to lose some embossing height and definition when heated to temperatures of 150°F to 180°F. If overlays are to be subjected to heat cycle testing, please note this in specifications so appropriate materials and processing can be used.

Polycarbonate can be readily embossed in thickness up to .010" (.254mm) with embossing on heavier materials (up to .020" [.508mm]) attainable with certain configurations. The most common thickness for polycarbonate keyboard overlays is .007" (.178mm).

Polyester overlays are normally either .005" (.127mm) or .007" (.178mm), due to the cloudiness that occurs in this material in heavier stock. While both .005" (.127mm) and .007" (.178mm) are commonly used, .005" (.127mm) is somewhat preferable from a fabrication standpoint, and we suggest specifying it where there are no other determining factors.

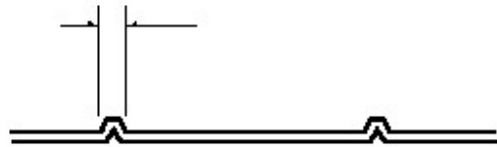
Embossing Dimensions

No discernible variation in texture or gloss of part should be acceptable when inspected per above.

Embossing Width

A minimum emboss width of .040" (1.016mm) on .005" (.127mm) and .007" (.178mm) material is recommended, and .050" (1.27mm) minimum width if the material is .010" (.254mm). While somewhat thinner emboss

widths can be achieved, this tends to distort the surrounding material and excessively stresses the stock in the emboss areas and could possibly result in fracturing at a later date. NOTE: If adhesive liner is not zoned away from the emboss area, its thickness must be added to material thickness when determining minimum width.



Embossing Height

It is recommended that the emboss height not exceed 2.5 times the thickness of the material (excluding adhesive liner), with the material thickness included in the measurement.



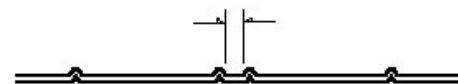
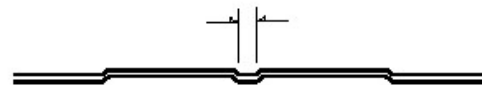
Emboss heights in excess of this recommendation may be achieved, but the risk of material failure is increased.

Emboss Spacing

The recommended spacing between emboss areas should be no less than .06" (1.5mm).

Emboss spacing below these minimums may lead to material failure and/or distortion of the overlay.

All embossing techniques result in thinning of the material in the sidewall areas. This area can be expected to fail first in cycle testing. If extended cycling is a consideration, polyester is indicated as the preferred base material, however, polycarbonate can withstand



cycling of over 10 million cycles if designed properly and used with compatible ink systems.

Registration

A tolerance of ± 0.010 " (.254mm) is standard for registration of emboss to printing and emboss to finish cut (perimeter and cutouts). A tolerance of $\pm .005$ " (.127mm) can be achieved, but this will result in a higher cost due to increased spoilage and slower running speeds. Emboss to emboss (spacing) tolerance is $\pm .005$ " (.127mm).

Tooling For Embossing

Dies for embossing can be matched male/female or either male or female with a rubber counter die. Materials include metals such as zinc, magnesium, brass, aluminium and steel, as well as polyester/fibreglass and silicone rubber. Sharp detail usually requires the use of metal dies. It is common for metal dies to be mounted to heated plates during the emboss operation.

Dies should be designed so the clearance between the male and female sides is approximately equal to the film thickness. Minimum draft angles of 3° should be designed into both male and female walls.

To keep localised stresses in the embossed overlay to a minimum, embossing dies should contain no sharp corners at points in contact with the film. Radii at all internal corners will reduce stress concentration and help prevent failure from fatigue or impact. As a rule of thumb, radii should be equal to, or greater than, the thickness of the film. In other words, a 0.250 mm thick film should contain a 0.250 mm minimum radius at any corner.

The variables involved in emboss tooling and in the emboss process include male/female die clearance, angle of draft on tooling, die temperatures, dwell time, and pressure. The exact specifications are determined by the supplier for each application and are considered to be proprietary.

Adhesive Backing

If adhesive backing is required on the embossed overlay, the adhesive should either be held back from the embossed areas ("zoned"), or if adhesive is needed in the keypad areas, an adhesive with a polyethylene liner should be specified. If standard paper liners are used in the emboss areas, they will tend to separate along the emboss lines making it difficult to remove the liner for application.

Backlighting of Embossed Areas

If embossed areas are to be backlit, this must be specified on the blueprint, since many inks will tend to fracture slightly during embossing (this fracturing is not visible in non-

backlit applications). If the part is backlit, appropriate processing will be used during production to minimize this problem.

Tolerances

A tolerance of $\pm .005$ " (.127mm) is standard on embossing height and width. As previously noted, a tolerance of $\pm .010$ " (.254mm) is standard on registration of embossing, and $\pm .005$ " (.127mm) on spacing.

COSMETIC SPECIFICATIONS AND INSPECTION GUIDE FOR SCREEN PRINTED FRONT PANELS

General

Cosmetic inspection of plastic front panels shall use the "Time and Distance" inspection procedure described below and shall rely on the judgment of trained inspectors and suppliers as no specification can be written to take into account all combinations of conditions that might exist. The Cosmetic Reference Standard defined in this Specification is to be used for training and guiding inspection personnel and may be used to assist in making an accept/ reject decision. No panel shall be accepted that has a combination of flaws that would obviously suggest inferior workmanship or processing.

Section I

Types of front panels covered by this specification include:

- Type I Smooth finishes with protective hard coatings or laminates
- Type II Textured finishes without protective hard coatings or laminates
- Type III Textured finishes with protective hard coatings or laminates

Viewing Conditions

All front panels shall be viewed stationary on a fixture or held at 45 degrees to the horizontal. The line of sight shall be perpendicular to the plane of the part and at a distance of 450mm (18 inches). Lighting conditions shall be uniform (diffused) fluorescent light from 75 to 100 foot candles. Viewing time shall be 20 seconds or as specifically agreed upon and documented between buyer and seller. Panels larger than approximately 150 mm x 450 mm (6 inches x 18 inches) and panels with large amounts of small type may require more than 20 seconds for adequate inspection. Smaller panels may require less than 20 seconds. Three seconds is perhaps a minimum inspection on a small panel; 60 seconds is perhaps a maximum on a large complex panel.

Windows within panels shall be inspected separately as outlined in Section II.

Judging Criteria

The clarity and completeness of screened copy, the consistency of color in copy and background, the surface finish and registration all shall be examined within the 20 allotted seconds. Color match will be judged separately on a single or random sample basis drawn from each shipment.

JUDGING

1. Colors

- A. Matches shall be in one of two categories:
 - 1. A "Standard color match" shall be a close color match to the customer's color sample or call out.
 - 2. A "precise color match or near precise color match" shall be a match that is as close as humanly possible to the customer's color sample or call out. "Precise color match" are not always possible as some pigments required for "precise matches" are not lightfast and/or are not available for use in the type of ink or paint required for the printing or decorating process selected.
- B. In many cases, a visual comparison of a matched color to a customer supplied sample is adequate. If a more objective inspection is required, a spectrophotometer linked to a computer such as offered by ACS or MacBeth is needed. Please see chapter specifically dealing with color for more detail.

PMS colors are formulas based on inks that are somewhat transparent applied to a white surface. They should not be called out if close color matches are required. Use paint manufacturer's chips, Federal Standard 595 chips, Munsell chips or opaque colored or painted plastic or metal parts for best results.

- 2. Screen printing of letters, numbers and lines "A" Quality; for "B" Quality, double the number of allowable flaws.
 - A. Broken letters, numbers and lines that affect legibility:
 - B. Broken letters, numbers and lines that do not affect legibility and are not wider than 0.5 mm (.02"):
 - C. Flaws permissible within any 76.0 X 76.0 mm area (3.00" X 3.00") or in any single word or name:
 - D. Flaws in size under 0.10 mm (.004") do not count

- 3. Surface finish, material and screened background flaws - two categories: A. Contrasting in color; B. Non-contrasting in color.

- A. Contrasting in color (generally in screening or within the plastic material itself)

1. Smearing, bleeding, flowmarks, inconsistency (See Section IV, Definitions):
 2. Voids, scratches, fill-ins and specks (includes areas where contrasting colors join):
 - A. Circular maximum diameter- 0.5mm (0.020") diameter:
 - B. Linear maximum dimension -- 0.25 X 1.0 mm:
 - C. Maximum "A" flaws in a panel:
 - D. Flaws in size under 0.10mm (.004") do not count.
- B. Non-contrasting in color (generally in coating or surface of plastic materials)
1. Smearing, bleeding, flowmarks, inconsistency, haze (See Section IV, Definitions):
 2. Voids, scratches and specks:
 - Circular -- maximum dim. 1.0mm (.04") diameter:
 - Linear -- maximum dim. 0.25mm X 2.54mm (.01" X .10")
 - Maximum "B" flaws in a panel
 - Flaws in size under 0.10 mm (.004") do not count.
 -
- C. Flaws permissible within any 76.0 X 76.0 mm area (3.00" X 3.00")

4. Maximum permissible flaws in any one front panel from Section I and/or 11: As stated in the first paragraph of this Specification, no panel shall be accepted that has a combination of flaws, which would suggest inferior workmanship or processing.

5. Registration

- A. Screen printing to screen printing (color to color) ± 0.25 mm (.010")
- B. Screen printing to sheared or die cut holes and/or edges ± 0.38 mm (.015")
- C. Screen printing to embossing ± 0.25 mm (.010")
- D. Part dimensional tolerances,
 - Class "A" Tools ± 0.15 mm (.006")
 - Steel Rule Tools ± 0.25 mm (.010")*

*Steel rule tools are usually acceptable for parts up to .020 thick for short to medium runs. They will usually last longer and cut better and more accurately: on thinner stock; on parts with larger cutouts; on parts where no cutouts are closer together than 10.0 mm (.394"); and on round cutouts as opposed to square or rectangular cutouts. The closer cutouts are to each other or to the edge of a part, the more "pucker" type distortion will occur.

Section II Panel Windows

- Types:
- 1) Clear or tinted plastic
 - 2) Transparent screen printed

Judging Criteria

Both types of windows shall be inspected only in conditions that simulate actual display use. They shall not be examined by attempting to look through them as you would look through a pair of glasses or a picture window or on a light table.

Viewing Conditions

All panel windows shall be viewed stationary on a fixture or held at 45 degrees to the horizontal. The line of sight shall be perpendicular to the plane of the part and at a distance of 450mm (18"). Lighting conditions shall be uniform (diffused) fluorescent light from 75 to 100 foot candles. Viewing time shall be 10 seconds.

Windows of all types may have one visible surface flaw per window for "A" Quality or three for "B" Quality. The flaw or flaws may be up to 0.5 mm diameter (.02") in size. The window may have many other flaws, scratches or pin holes of any size that are invisible in simulated or actual use.

Section III Worst Condition (Still Acceptable)

"A" Quality

Worst condition when viewed for 30 seconds (20 for panel, 10 for window) under specified conditions, 6 flaws as described above in a Type I panel, 4 flaws in a Type II or a Type III panel.

Double the numbers for "B" Quality.

INK ADHESION TEST

Every production run of parts should be tested for ink adhesion using ASTM D3359-78. Briefly, the test is performed as follows:

1. A series of 11 straight line cuts are made through the ink to the substrate using a knife or razor blade. The cuts should be 1/8" (3.175mm) apart and approximately 3/4" (19.05 mm) long.
2. Another series of cuts is made at 90 degrees and centered on the original cuts.
3. Use 1" (25.4 mm) wide transparent pressure sensitive tape with an adhesion strength of 36 ±2.5 oz./in. (25.4mm). Cut a piece about 3" (76.2 mm) long and place the center of the tape over the grid area and smooth into place firmly.
4. Within 90 seconds of application, remove the tape by seizing one end and rapidly (not jerked) pulling it off at as close to an angle of 180 degrees as possible.
5. The ink adhesion will be acceptable if it meets rating 4B which reads as follows: "Small flakes of the coating are detached at intersections; less than 5% of the area is affected."

III.3 DECALS

Originally, the term “decal” was an abbreviated form of the French “decalcomania,” which denoted a picture, or design printed on special paper for transfer to a selected substrate. With the development and acceptance of pressure sensitive adhesives and other similar formulations, “decal” became the popular nomenclature for any emblem, or marking which was externally processed prior to application. Today, the term defines a variety of thin, flexible products, consisting of the following:

- Face Stock (base or substrate)
- Pressure Sensitive Adhesive
- Release Liner or Carrier

In some cases, decals provide the simplest, most effective method of meeting a customer’s requirement, as in the example of tamperproof warning labels to comply with government regulations. With a wide range of substrates, inks, and adhesives currently available, designers have the ability to build composites that can stand up to a host of durability requirements. Decals are produced to resist environmental elements, cleaning agents, and acids just to name a few. They can be engineered to adhere permanently to a textured surface, or to be removed without adhesive residue. The applications are endless.

Decal selection offers a number of advantages over rigid substrates. Some metal identification products have been converted to single, or multi-laminate plastic products to gain the desired design look, or for economic reasons.

The use of a decal’s adhesive system can eliminate mechanical fasteners, offering further cost reduction. Another advantage can be the flexibility to contour around bends, or over raised areas. Plastic substrates also allow the utilization of special techniques such as the transparent windows, backlighting, or tinting.

Decals may have some limitations, of course. Extremely high heat requirements can eliminate decals from consideration. Occasionally a mating part will carry deep impressions, or large raised spots from molding. The ability to cover these spots without aesthetic detracting can be a problem. In addition, if the end product will undergo temperature extremes, the thermal expansion ratio between the decal substrate and the mating part must be closely matched to avoid delamination.

Face stocks may range from various grades of paper to a wide variety of plastic films. This discussion will be limited to plastic films only. The choice of film will depend upon the aesthetics desired and the performance requirements for such markings.

Face stock should be selected to achieve the most desirable balance between cost and performance. Careful deliberation with the decal manufacturer and/or raw material supplier will insure that the chosen substrates, inks, and adhesives are correctly

matched to the intended application. Please refer to the Chapter III.1 PLASTIC TYPES for a listing of the most commonly used face stocks and their properties.

Pressure sensitive adhesives are discussed in depth in another section of this book. However, it is worth mentioning that in recent years, suppliers of decal substrates have greatly improved upon pressure sensitive adhesive technology. In addition to general purpose removable and permanent adhesives, specialty adhesives are readily available to meet most any customer requirement. A few such special requirements include:

- High temperature performance.
- Low temperature performance
- Direct food contact
- Autoclavable
- Repositionable
- Acid resistant

Applications with such special requirements should be discussed with your supplier.

Release liners are simply carriers to protect the adhesive through processing to its final application. However, just as with face stocks and adhesives, release liners are tailored to many specific requirements, which the end user may need for processing. Several specific types of liners are:

- Moisture stable “lay flat” liners
- High speed automatic dispensing liners
- Printable release liners
- Liners with special die cutting properties
- Film type release liners Special requirements should be brought to the attention of your supplier.

PRINTING

Decals and plastic based nameplates are printed commercially by a number of methods including flexography, letterpress, offset and screen printing. Screen printing offers some advantages due to its unique ability to provide increased ink deposit, and the durability of the ink formulations. Thus, where opacity, or environmental concerns surface, screening is normally chosen. On the other hand, the balance of the print processes generally find it easier to hold very fine detail, and frequently are most cost effective, when the decal specifications do not contain rigid performance criteria. In any case, the prepared artwork is transferred to the appropriate print media in the same manner as other printed products. The substrate may then be printed in roll or sheet form, one color at a time, or all colors in the same machine pass. Printing may be accomplished with conventional (solvent) ink, or ultraviolet formulations.

ETCHING

Decal etching differs from metal etching in that it allows the producer of the label to give a chrome metallized look, and a brushed metallized appearance on the same piece of work.

EMBOSSING

Through heat and pressure applied by a press, the decal may be embossed in register to the printing. The pattern variations that can be developed are nearly limitless.

LAMINATING

The printed work may be laminated to protect the product, or to gain an additional aesthetic accent. Using a variety of materials, laminating may be performed in line with the coating and curing of the adhesive, or as a “dry” process using rolls of precoated substrate. The adhesive may be pressure sensitive, heat activated, or solvent activated. Common materials used to overlaminate include polyester, polyethylene and polypropylene. Printed work may also have the application adhesive and release liner laminated to it, as is common when the product is subsurface printed. Some manufacturers have the ability to perform coating of the adhesive in line, while laminating the printed stock.

SLITTING

The liner protecting the application adhesive may be slit with blades to allow easier removal by bending and peeling the decal. Some manufacturers substitute a score in place of a slit that cracks open when bent. Still others provide a tab that is cut during die cutting to facilitate liner removal.

DIE CUTTING/KISS CUTTING

The great majority of decals are die cut using steel rule dies and flat bed presses or are die cut using rotary dies when accompanying flexographic printing. The term kiss cut refers to the process of penetrating the printed substrate with the steel rule tool, leaving the release liner intact. The unwanted matrix is then stripped away, resulting in either sheets, or rolls of the decals neatly spaced and ready to be lifted from the liner and applied. If automatic application equipment is used, this format is normally a necessity.

WASTE STRIPPING

The process of removing waste from die cut parts can be a labor intensive and costly procedure. There are machines and jigs available from your die supplier that can be used to reduce this cost and improve product flow efficiencies while eliminating the ergonomic liabilities that come with waste stripping by hand.

POWER CUTTING

When the decal’s configuration is a simple square, or rectangle, and dimensional tolerances are not critical, the sheets, or labels may be sheared by a powercutter to

their final size. This method is cost effective compared to die cutting and, of course, eliminates tooling purchase.

Tolerances produced are normally somewhat less than die cutting.

FINISHING

In addition to the substrates, some decal producers have developed textures and specialty printable coatings to add the aesthetic value of a gloss and matte (or textured) appearance on the same part. Other functional coatings may provide resistance to abrasion, increase weatherability, improve printability for computer applications or give chemical resistance.

DESIGNER SUGGESTIONS

Offered below are a few suggestions that can aid the purchaser of decals in obtaining the product that best fulfills his needs.

1. Set tolerances no tighter than they really need to be. In general, more stringent tolerances result in a higher price.
2. Provide clear and specific information concerning the desired performance of the product. Take the time to consider such end use requirements as temperature extremes, weatherability, abrasion resistance, or chemical contact. If the mating part is also plastic, experience has taught that the intended adhesive must be tested on the actual material to be completely reliable.
3. When selecting colors, use a commercial book, such as the Pantone System, to communicate your desires to the producer. Verbal descriptions of color can prove to be a hazardous practice and typically produce poor results.
4. Avoid graphic designs that prevent the printer from overlapping the edges of colors. These bleeds, as the industry refers to them, are necessary to insure correct registration, and are not apparent in the finished product.

In conclusion, the market for pressure sensitive decals is expanding. Applications become more sophisticated each year. Communication is the most important key to successfully producing these products. Communicating with your customer, and with your supplier will help avoid the pitfalls that may accompany any growing industry.

SECTION IV: ESSENTIAL REFERENCE TOOLS

APPENDIX A: INSPECTION AND QUALITY CONTROL

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1.0 PURPOSE

The purpose of this document is to establish a common set of cosmetic inspection standards for use by GPI member companies (manufacturers), their customers and suppliers. These standards shall constitute both the manufacturer's and the customer's acceptance standards unless otherwise specified by the customer or customer drawing or specification. The inspection standards included in this document define what is acceptable and under what conditions.

2.0 SCOPE

This document is intended for use during the Receiving, In-process and Final Inspection of printed items such as labels, nameplates and graphic overlays (with or without a membrane switch). The cosmetic appearance of these printed items is usually determined by visual inspection. The ultimate decision on a printed item's acceptability is its visual appearance when viewed on the equipment, preferably by the end user. Minor flaws are inherent to the materials used and the printing processes involved. Customers may find that a part is cosmetically acceptable even though minor flaws are discernible. A judgment must be made as to whether or not the end user would consider the flaws objectionable.

3.0 DEFINITIONS

Adhesive Imperfections – Any variation in the adhesive that is visible under the defined viewing conditions. This may be caused by air bubbles or defects in the adhesive that can be seen through the overlay due to a lack of ink opacity or adhesive “balls” that create a visible bump or bulge in the overlay's surface.

Apparent Color Variation – Any unintended variation in the perceived color that is visible under the defined viewing conditions.

Blip – A spot of ink that extends beyond the boundaries of text or other graphics.

Blur – Printed defects such as shadowing, “ghosting” or static lines that cause the printed image to look undefined or out of focus.

Class A Product – Parts which are primarily of a decorative nature and aesthetically required to enhance the eye appeal of the product on which it is used. The Acceptable Quality Level to be used is 1.5 per Mil-Std-105E

Class A Surface – Directly viewed smooth inked surface.

Class B Product – Parts which are primarily for identification and/or instruction which are exposed on the outside and in full view when the product is on display or in use. The Acceptable Quality Level to be used is 2.5 per Mil-Std-105E.

Class B Surface – Indirectly viewed smooth inked surface.

Class C Product – Parts which are not normally exposed when the product is displayed or in use. The Acceptable Product Quality Level to be used is 4.0 per Mil-Std-105E.

Class C Surface – Unseen inked surface.

Contamination – Foreign particles located in the part usually caused by airborne materials (such as dirt or lint) that become lodged in the ink during printing.

Crease – A witness mark in the material or part caused by overflexing of the material during handling, punch-out or die-cutting.

Dent – Indentation of a part's surface caused by blunt object contact or a "fingernail" witness mark.

Fish Eye – A crater-like defect on a part caused by contamination (or a pinhole in the sheet's print treatment) during the printing process.

Hardcoat Delamination – The condition when the gloss or matte hardcoat separates from the top surface of the material. This often occurs at the part's corners or near die-cut edges. The delaminated hardcoat often looks lighter in color or more matte than the normal hardcoat appearance.

Ink Delamination – The condition when ink separates from the substrate. It is often noticed near a part's corners or where the ink appears "lighter" or "frosty."

Pinhole – A tiny hole or void in the ink that permits light to pass through a printed area. A pinhole can also allow the color of a printed sub-layer to show through to the layer printed over top of it (usually in the form of a small dot that is a different color than the feature being viewed).

Printing Misregistration – Layers of ink that are not aligned allowing the sub-layer of ink to show (undesired). This can typically be seen in the printed colors on the part itself or within the color bars and print targets located on the screenprinted sheet.

Scratch – Marks in the printed part or sheets caused by some sort of abrasion; this is typically caused by part-on-part or sheet-on-sheet contact without some type of slipsheeting. Scratches are usually long and narrow in nature. They are more apparent in clear display windows or on the top surface of a matte or glossy finished part.

Smear – Incidental rubbing or smudging of wet ink (usually by another sheet or a finger) creating a long streak of ink that is usually blurry and distorts the text or character that was touched.

Stray Spot – This type of defect is typically a dark colored spot on a light background or window or a light colored spot on a dark background. It can be created by the printing process or by defects or contaminants in the material or hardcoat. Several small spots that are close enough together as to appear as a single spot, without magnification, shall be considered one spot.

Streak – A long, stripe-like defect in a printed area that looks discolored (lighter or darker than the surrounding printed area of the same color); these are usually caused during the print process by a "jumping" squeegee or problems with ink viscosity.

4.0 INSPECTOR QUALIFICATIONS

- 4.1 Inspectors shall have been trained in the use of this inspection standard.
- 4.2 Inspectors shall have either unaided, or corrected, 20/20 vision.

5.0 INSPECTION TOOLS

- 5.1 Under this Cosmetic Inspection Standard, parts are inspected under the prescribed viewing conditions (see Section 6.0) with an unaided eye. Once defects are noticed with the unaided eye per the outlined procedure, inspection tools may be used to measure their size to determine if they are large enough to be considered unacceptable.
- 5.2 Inspection tools that may be used are:
 - 5.2.1 Digital Calipers
 - 5.2.2 7X to 10X loupes (Comment: We use 7X loupes)
 - 5.2.3 Films with standard defect sizes (diameters and lengths) portrayed.
 - 5.2.4 Opacity inspection grids (.125" black grid on white background).

6.0 VIEWING CONDITIONS

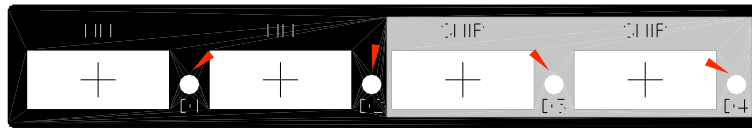
This section describes the required viewing conditions when inspecting parts under this Cosmetic Inspection Standard.

- 6.1 **Lighting** – Inspection shall be performed under overhead fluorescent lighting producing more than 70 foot-candles . (Comment: We use 100 – 175 foot-candles)
- 6.2 **Viewing Distance** – Visual inspection of all cosmetic-type defects will initially be performed without the use of any form of magnification. Inspection shall be performed at a distance of 18 inches. If a defect is considered suspect, magnification can be used to confirm its size.
- 6.3 **Viewing Angle** – During inspection, parts shall be held at approximately 45 degrees to the horizontal so that the part’s surface can be inspected without glare (from the overhead lighting) that may otherwise hide cosmetic defects from detection. The viewing line of sight shall be perpendicular to the part. Once the correct inspection angle is determined for the particular part, the viewing angle shall not be changed during the inspection process.
- 6.4 **Magnification** – Magnification shall only be used to confirm the size of defects.
- 6.5 **Special Viewing Conditions for Windows in Graphic Overlays**

Windows should be inspected under conditions similar to the viewing conditions the part will experience in its end use. If possible, the actual functional display to which the part will be assembled shall be used to inspect the parts. If the appropriate customer-supplied lighted unit cannot be obtained, the following viewing conditions for the three different window types (see below) may be used.

TYPE 1: SMALL LED WINDOW	BACKGROUND or BACKLIGHTING
This type of window is typically small, clear (gloss or textured) and round or rectangular in shape. They are typically located over top of LEDs mounted to a membrane switch or circuit board.	Inspect on a light table or hold up to overhead light producing 70 to 100 foot-candles at any point on the part.

LED Windows



TYPE 2: TINTED DISPLAY WINDOW

This type of window is typically larger than the small LED windows. They can be clear or printed with colored transparent inks (such as red, blue, green and smoke or deadfront). They can be textured or clear. These types of windows typically cover LED displays, like the large red text displays on equipment controls or scrolling message boards.

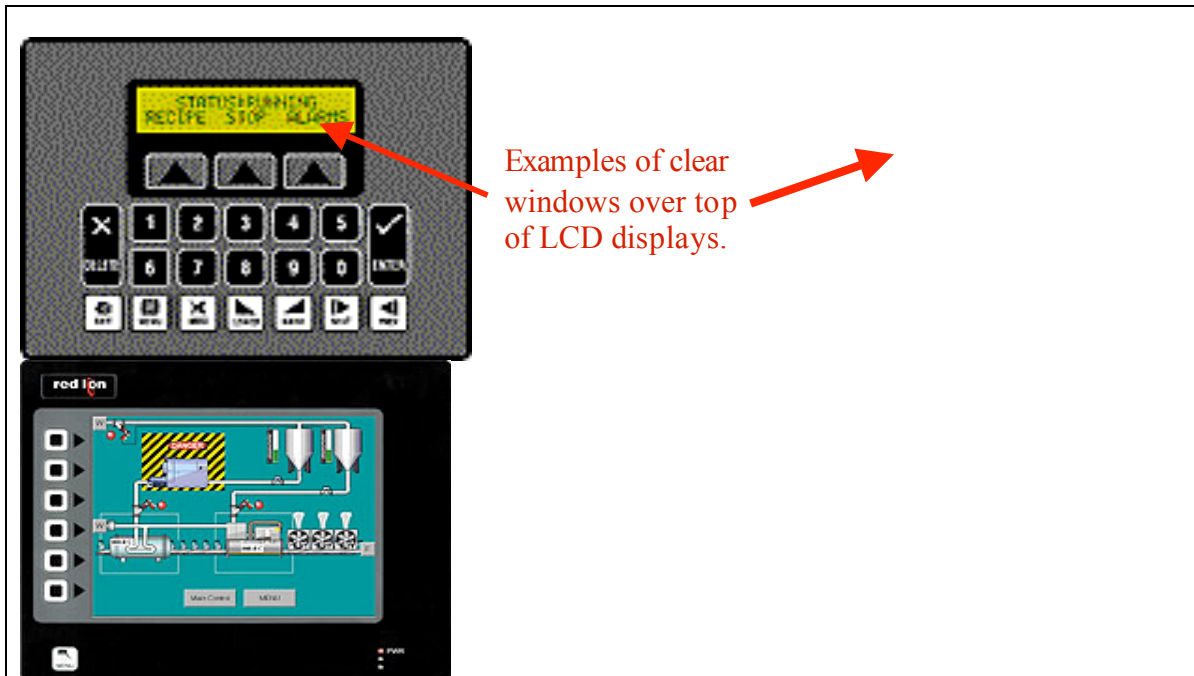
BACKGROUND or BACKLIGHTING

Inspect on a light table or hold up to overhead light producing 70 to 100 foot-candles at any point on the part.

If you are not sure a defect will be visible when backlit by a customer's unit, hold the window against Butler Tech's sample LED display to check.



TYPE 3: Clear Display Window	BACKGROUND or BACKLIGHTING
<p>Clear display windows may have a gloss or anti-glare finish. These types of windows are typically used over top of LCD displays and touchscreens.</p>	<p>Inspect on a light table or hold up to overhead light producing 70 to 100 foot-candles at any point on the part to see if any defects become illuminated by backlighting.</p> <p>If the window needs to be inspected on a background that simulates a non-lighted LCD background (black), lay the window over a piece of matte black foam and inspect for defects.</p>



Note: If we cannot get a display from our customer, we use a printed gray half-tone pattern. I would be happy to send you one. If we agree that matte black foam is to be the background, I would like to see us be more specific with a manufacturer and part number to ensure repeatable viewing conditions.

7.0 VIEWING TIME

7.1 Inspection viewing time will be based on the part size as follows:

Part Size (in ² = L x W)	Maximum Viewing Time
0 to 25 square inches	5 seconds
26 to 50 square inches	10 seconds
51+ square inches	15 seconds

NOTE: An additional 5 seconds of viewing time may be used when evaluating windows.

8.0 ALLOWABLE DEFECTS

The following section outlines the acceptance criteria for parts inspected under this specification. Parts shall not be rejected for flaws that are not observed under the prescribed viewing conditions and allotted time.

8.1 Pinholes / Stray Spots / Contamination / Lint / Printing Defects

8.1.1 These types of defects are generally round or irregular in shape and are typically defined by their total cumulative diameter.

8.1.2 See **Chart 1** for the size and number of allowable defects.

- 8.1.3 **NOTE:** These types of defects found in a part are counted separately from those found in a part's window(s).
- 8.1.4 **NOTE:** Any group of extremely small spots that appear as one spot, without magnification, will be evaluated/counted as one defect (spot).
- 8.1.5 **NOTE:** The clear area in a pinhole or fisheye-type defect will determine the size of the defect.

8.2 **Scratches**

- 8.2.1 Scratches are defects long in nature and are defined by their length and width.
- 8.2.2 See **Chart 1** for the size and number of allowable defects.
- 8.2.3 **NOTE:** Scratches found in the body of a part are counted separately from those found in a part's window(s).
- 8.2.4 **NOTE:** Any group of extremely small scratches that appear as one scratch, without magnification, will be evaluated/counted as one defect (scratch).

8.3 **Window Defects**

- 8.3.1 Window defects include those specified in Section 8.1 and Section 8.2.
- 8.3.2 Window defects are counted separately from the defects found in the rest of a part.
- 8.3.3 See **Chart 2** for the size and number of allowable window defects.
- 8.3.4 **NOTE:** Each window is treated separately when determining the number of allowable window defects.

8.4 **Color Variation / Opacity / Streaks**

- 8.4.2 Color variation of opaque colors shall be held within the limits given below:
 - a) Color limits initially set by the customer (either color chips or numerical limits).
 - b) Color limit chips developed by graphics supplier and approved by the customer.
 - c) Colors held within a delta E of ± 1.5 when measured with a spectrophotometer.

Color variation of transparent colors must pass a visual inspection by comparing production parts with approved customer samples, viewed over a fluorescent light source of 70 to 100 foot-candles by an inspector with normal color perception. If the transparent color is in a window, refer to Section 6.5, Type 2 window.

- 8.4.4 Opacity of printed colors (opaque spot colors) will be determined by placing the part over a .125" black grid of .025" wide lines on a white background. The color's opacity will be considered acceptable if the grid is not visible through the color when the part is inspected per the prescribed viewing conditions.

Comment: This standard is more strict than our practices. It seems like we may be driving cost into printing an overlay that is being applied to a case that has a similar color to the background color of the overlay?

- 8.4.5 Streaks (lighter or darker than the surrounding printed areas of the same color) visible from 18 inches under the prescribed viewing conditions are not acceptable.

8.5 **Lettering / Characters / Borders**

- 8.5.1 No defects (spots, smears, missing letters, etc.) that affect the meaning, intent or legibility of the part are allowable.
- 8.5.2 No misspelled words are allowable.
- 8.5.2 Imperfections in characters, lettering and borders shall be no greater than .020”.
- 8.5.3 Color shadowing or “ghosting” shall not be visible at 18 inches under the prescribed viewing conditions.

8.6 **Delamination**

- 8.6.1 Any delamination of ink, hardcoat, printed texture or overlaminated materials that is apparent at 18 inches under the prescribed viewing conditions is cause for rejection.

8.7 **Print Registration (color-to-color) / Graphics Registration (cut/emboss-to-print)**

- 8.7.1 Color-to-color misregistration of printing visible from 18 inches under the prescribed viewing conditions is not permitted.
- 8.7.2 Color-to-color misregistration of printing that causes a color to protrude into a window, compromising the window’s function or aesthetics, is not permitted.
- 8.7.3 Graphics shall visually align with cut-outs, windows, part edges and embossed areas unless otherwise specified by the customer or Butler Technologies, Inc.

8.8 **Condition of Cut Edges and Embossed Areas**

- 8.8.1 Edges of die-cut pieces will not show feathering (strings) visible at 18 inches.
- 8.8.2 Edges of die-cut, laser-cut or plotter-cut pieces will not show coating or ink delamination visible at 18 inches.
- 8.8.3 Plotter-cut pieces shall not exhibit “plowed” edges visible at 18 inches.
- 8.8.4 Laser-cut pieces shall not exhibit burn marks on the part’s face visible at 18 inches.
- 8.8.5 Embossed areas shall have only minimal cracking at edges (visible in backlit areas only).

8.9 **Adhesive Imperfections**

- 8.9.1 Any adhesive imperfection that is visible in the part under the prescribed viewing conditions is cause for rejection.

8.10 **SPECIAL NOTE:**

Because of the subjective nature of aesthetic acceptability, some defects are difficult to discern even with the parameters defined within this specification. When these situations arise, the defect will be considered acceptable only if it cannot be detected by two different inspectors under the parameters prescribed in this specification without prior knowledge of the other inspector’s results.

8.11 **Defect Charts and Pictorials**

Comment: I am not sure there is enough difference between a 1-square-inch box and a 3-square-inch box. In theory, a Class A 60-square-inch part could have up to 40 defects on it. What do you think about changing from 3 to 9 and making a small increase in the number of defects allowed?

I would also like to change all references to “Allowable Defects” to “Allowable Minor Defects”

Chart 1 (Size and Number of Allowable Defects per Part, not including window defects)			
Part Class (see Section 3.0 Definitions)	Length x Width Or Total Cumulative Diameter	Maximum Number of Part Defects per Square Inch	Maximum Number of Part Defects per Three Square Inches
A	.25” Long x .003” Wide or .020” diameter	1	2
B	.50” Long x .003” Wide or .040” diameter	1	2
C	.50” Long x .003” Wide or .040” diameter	3	6

PLEASE NOTE: The total number of allowable part defects of either a single type (scratches or spots) or combination of the two types is not to exceed the limits specified per square inch.

Chart 2 (Size and Number of Allowable Defects per Window – counted separately from part defects)			
Part Class (see Section 3.0 Definitions)	Length x Width Or Total Cumulative Diameter	Maximum Number of Window Defects per Square Inch	Maximum Number of Window Defects per Three Square Inches
A	.25” Long x .003” Wide or .020” diameter	1	2
B	.50” Long x .003” Wide or .040” diameter	1	2
C	.50” Long x .003” Wide or .040” diameter	3	6

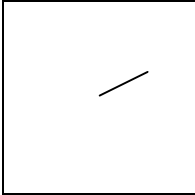
PLEASE NOTE: The total number of allowable window defects of either a single type (scratches or spots) or combination of the two types is not to exceed the limits specified per inch.

PLEASE NOTE: The total number of allowable window defects is counted separately from the total number of allowable part defects.

Pictorial A below shows examples of the allowable defects for a Class A part based on Chart 1 and Chart 2 above. The one-square-inch and the three-square-inch boxes show the approximate size of the areas used to determine the number of defects per a prescribed area. As seen in the pictorials below, the allowable number and size of defects changes from Part Class A through Part Class C.

Pictorial A (Example of Allowable Defects for Class A part based on Charts 1 and 2 above)

One Square Inch

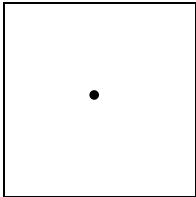


Three Square Inches

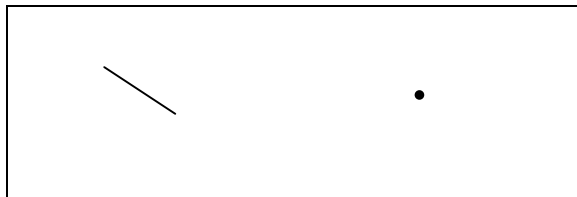


Pictorial B (Example of Allowable Defects for Class B part based on Charts 1 and 2 above)

One Square Inch

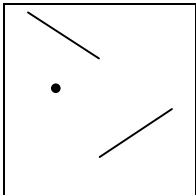


Three Square Inches

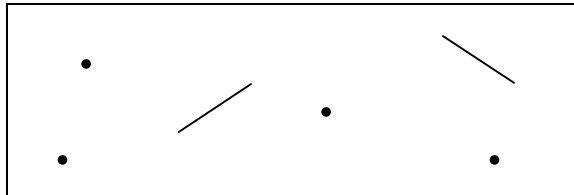


Pictorial C (Example of Allowable Defects for Class C part based on Charts 1 and 2 above)

One Square Inch



Three Square Inches



9.0 REFERENCES

National Association of Nameplate Manufactures Inc. (NAME), Nameplate Industry Standards and Practices, 3rd ed., 1987

ASTM, Standard F 1595, Standard Practice for Viewing Conditions for Visual Inspection of Membrane Switches, 1995

APPENDIX B: REFERENCE TABLES

The following chapter is a partial list of Government and Military Specifications that are applicable to the Nameplate Industry. These Specifications, and Revision Numbers are current as of January, 1986. To find Current Revision Numbers please refer to:

“Department of Defense Index of Specifications and Standards” which is issued July 1st of every year, along with quarterly supplements. This publication may be obtained from:

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

Copies of Military Specifications may be obtained by writing:

Naval Publication and Forms Center
5801 Tabor Avenue
Philadelphia, Pennsylvania 19120
(215) 697-3321

Copies of Federal Specifications and Standards should be ordered through:

General Services Administration
Specifications Unit(WFSIS)
7th and D Streets, N.W.
Washington, D.C. 20407

APPLIANCE AND DEVICE ASSOCIATION STANDARD REQUIREMENTS

In both the United States and Canada electrical appliances, motors, and similar products as well as gas appliances and devices frequently require the approval of the appropriate nonprofit cooperative standards and/or testing organization. In the United States this is the American Gas Association and Underwriter's Laboratories Incorporated, and in Canada the Canadian Standards Association. Procedures for qualification by these organizations are similar.

Nameplate suppliers must submit three copies of proofs at the same time proofs are submitted to customers, and proceed no further until approval is received from both the customer and the Association. Resubmission is not required on nameplates reordered without revision.

With such standards approval, name- plates may show the crest of the rate-approving Association as indication of acceptable safety features (of the appliances involved).

Adhesive-backed plates, particularly in Canada, must pass extensive indoor and outdoor nameplate quality tests prior to receipt by the manufacturer of rating as an approved source.

NAMEPLATE IMPORTS AND EXPORTS

Nameplates imported and exported must normally be marked with the country of origin, usually on the border, with appropriate text such as: N.P. printed in U.S.A. This data may alternately be marked on shipping carton.

APPENDIX C: GOVERNMENT SPECIFICATIONS

MILITARY STANDARDS

MIL-STD-129J	Marking For Shipment and Storage
MIL-STD-130 F	Identification Marking of U.S. Military Property
MIL-STD-642 K	Identification Marking of Combat and Tactical Transport Vehicles
MIL-STD-792 D	Identification Marking Requirements For Special Purpose Components
MIL-STD-1189A	Bar Code Symbolology, Standard Department of Defense
MS-27253 B	Plate, Identification
MS-33558C	Numeral and Letter, Aircraft Instrument Dial, Standard Form Of
MS-53007 D	Plate, Identification, Emergency and Service Automotive Air Brake
MS-63203 B	Plate, Identification, Modification Applied
MIL-STD-45662	Calibration System Requirements
GG-P-455B (2)	Plates and Foils, Photographic, Photosensitive Anodized Aluminum

MIL-P-514 D (2)	Plate, Identification, Instruction and Marking, Blank
MIL-P-3558 E	Plate Identification, Locomotives, Railway Cars, and Work Equipment
MIL-P-6906 B	Plate, Identification, Aircraft
MIL-P-7788 E (1)	Panel Information, Integrally Illuminated
MIL-I-8651 B (1)	Identification and Modification (For Aircraft) Installation Of
MIL-Q-9858 A (1)	Quality Program Requirements
MIL-M-13231 B (1)	Marking of Electronic Items
MIL-P-14631 A	Plate, Automobile, Individual, General Specifications For
MIL-P-15024 D (2)	Plate, Tags and Bands for Identification Of Equipment
MIL-P-15024/1 A	Plate, Identification Set or Group
MIL-P-15024/2	Plate, Identification Unit or Plug-In Assembly
MIL-P-15024/3	Plate, Tags and Bands, Band Identification, Cable
MIL-P-15024/4	Plate, Identification, Modification
MIL-P-15024/5	Plate, Identification
MIL-P- 15024/6 A	Plate, Identification

MIL-P-15024/7	Plate, Tags and Bands, Band Identification, Cable Assembly, Type K1 Aluminum
MIL-P-15024/8	Plate, Tags and Bands, Band Identification, Cable Assembly, Type K2, Heat Shrinkable Tubing
MIL-P-15024/9	Plate, Tags and Bands, Aircraft Loading Dataplate
MIL- P-15024/10 (1)	Nameplate, Ordalt Plates and Information Plates
MIL-P-15024/11	Plate, Identification, End Item Attachments
MIL-P-15024/12	Plate, Identification, Engine Overhaul Data
MIL-P-15024/13	Plate, Information, Service
MIL-P-15024/14	Plate, Information, Parts
MIL-P-15024/15	Plate, Tags, Hose Assembly Identification
MIL-N-18307 G	Nomenclature -Identification For Aeronautical Systems Including Joint Electronics Type Designated Systems-- Associated Support Systems
MIL-P-19611 B (1)	Plate, Automobile, Individual, Metal Emblem, and Star

	(Commandant S and General Officer S. USMC)
MIL-P-19834 B (2)	Plate, Identification, Metal Foil, Adhesive Backed
MIL-S-20633 B	Sign and Marker, Aluminum, Mined Area Marking
MIL-A-22895 (1)	Adhesive, Metal Identification Plate
MIL-M-43719 B (1)	Marking Materials and Markers, Adhesive, Elastomeric, Pigmented, General Specification For
MIL-M-43719/1 A	Marking Materials and Markers, Adhesive, Elastomeric, Pigmented, Letters and Numerals
MIL-M-43719/2 A	Marking Materials and Markers, Adhesive, Elastomeric, Pigmented, Legends
MIL-M-43719/3 A	Marking Materials, and Markers, Adhesive, Elastomeric, Pigmented, Symbols
MIL-M-43719/4	Marking Materials and Markers, Adhesive, Elastomeric, Pigmented, Hazardous Material Symbols
MIL 145208 A (1)	Inspection System Requirements

PAINT AND CHEMICAL TREATMENT SPECIFICATIONS

TT-V-109 C	Varnish, Interior, Alkyd-Resin
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MIL-V-173 C (2)	Varnish, Moisture and Fungus Resistant, For Treatment of Communications, Electronic, and Associated Equipment
TT-F-325 A (2)	Filler, Engraving, Stamped Marking
TT-E-489 G	Enamel, Alkyd, Gloss
TT-E-527 C	Enamel, Alkyd, Lusterless
FED-STD-595 A	Federal Standard Colors
MIL-C-5541	Chemical Conversion Coatings On Aluminum Alloys
MIL-A-8625 D	Anodic Coatings For Aluminum and Aluminum Alloys
MIL-F-14072 C	Finishes For Ground Electronic Equipment
MIL-E-15090 C (2)	Enamel Equipment, Light Gray (Formula No. 111)

METAL SPECIFICATIONS

QQ-A-250 F	Aluminum Plate and Sheet, General Specifications For
ALLOY 1100	QQ-A-250/1 F and MS-14357
3003	QQ-A-250/2 F
2024	QQ-A-250/4E (1) and MS-14361

2024 (Alclad)	QQ-A-250/5F(1) and MS-14358
5052	QQ-A-250/8 F
6061	QQ-A-250/11 F and MS-14362
7075	QQ-A-250/12F and MS-14360
7075 (Alclad)	QQ-A-250/13E (1) and MS-14359
QQ-A-1876	Aluminum Foil
QQ-B-613D	Brass, Leaded and Non Leaded, Flat Products (Plate, Bar, Sheet And Strip)
QQ-B-639 B	Brass, Naval, Flat Products (Plate, Bar, Sheet and Strip)
QQ-S-766C (5)	Steel, Plate, Sheets, and Strips, Corrosion Resisting (Stainless Steel)
MIL-S-5059 D (1)	Steel, Corrosion Resistant (18-8) Plate, Sheet and Strip (Stainless Steel)

SPECIFICATIONS FOR ANODIC COATINGS ON ALUMINUM

Mil - A-8625C - Anodic coatings for aluminum and aluminum alloys. Covers the requirements for three types of anodic coatings: Type I, chromic acid; Type II, sulfuric acid, and Type III, hard coating. Coatings may be ordered as undyed or dyed, specified as Class I or Class II, respectively. When the coatings are required, a color must be specified.

Mil - C-60539 - Conventional anodic coatings for aluminum alloys. Covers the requirements for anodic coatings produced from chromic acid bath (Type I) and sulfuric acid (Type II). These coatings may be ordered as undyed or dyed, designated as Class I or Class II, respectively. When dyed coating is required the color must be specified.

AMS- 2469C - Hard coating treatment process and performance requirements of aluminum alloys.

AMS - 2470G - Anodic treatments of aluminum base alloys-chromic acid process.

AMS - 2471 C - Anodic treatment for aluminum base alloys-sulfuric acid process, undyed coating.

AMS - 2472B - Anodic treatment for aluminum base alloys-sulfuric acid process, dyed coating.

ASTME - 376-69 - Certifies to anodic thickness by electromagnetic test methods.

ASTMB - 136-77 - Certifies to measurement of stain resistance of anodic coatings or sealing capacity.

ASTME - 244-68 - Measurement of anodic thickness with eddy-current instruments.

ASTMB - 487-75 - Measurement of anodic thickness by microscope cross section.

APPENDIX D: WORD GLOSSARY

Accelerated Aging

The term used for subjecting nameplates to certain environmental conditions to enable a prediction for the course of natural aging, but in a far shorter period of time.

Acrylic

A synthetic polymer with very good aging characteristics, and an initial tack that is relatively light to allow for repositioning; full strength is reached over time. Most transfer adhesives are acrylic.

Adhesion

The bond that is created when two surfaces come into contact.

Alloy

A substance that has metallic properties and is composed of two or more chemical elements, of which at least one is a metal.

Anneal

Annealing, in metallurgy and materials science, is a heat treatment in which the microstructure of a material is altered, causing changes in its properties such as strength and hardness..

Annodize

A process of adding a protective oxide film to metal (normally aluminum) by an electrolytic process.

Backing

The release liner that protects adhesives. It is removed prior to use of the product.

Bastard Layout

Unusual or irregular in shape, size, or appearance. A design term used to describe labels that are laid out in an irregular pattern. Also referred to as nesting.

Bezel

A grooved rim which holds another covering or item, like a frame.

Bitmap

An image data file representing a generally rectangular grid of pixels, or points of color, on a computer monitor, paper, or other display device.

Bleed

Background printing that extends beyond the specified dimensions of the part. Thus, when the part is cut at the specified dimensions, there is 100% ink coverage on the finished part.

Blocking

A condition created when one layer sticks to another layer within a roll or in sheet, thereby making it difficult to unroll or feed the sheets.

Camber

Curvature in the plane of a sheet of metal as compared to a straight line. Normally expressed in fractions of an inch per foot or mm/m.

Carrier

The material on which the adhesive has been coated, and on which it stays during use, often referred to as "face stock".

CCC Mark

The abbreviation of China Compulsory Product Certification is CCC. It is the statutory compulsory safety certification system and the basic approach to safeguard the consumer's rights and interests and protect the personal and property safety. The CCC has been widely adopted widely by international organizations.

Cheshire

The name of a specific machine designed to affix labels onto pages and/or envelopes which has become a generic name for this type of labeling.

Color Retention / Colorfast

The ability of a color to resist fading and other deterioration due to light exposure and aging.

CSA

Canadian Standards Association is a leader in safety standards testings. The CSA is a division of the CSA Group. Its mark appears on millions of products sold annually. It is

required by law for many products sold within Canada, and the mark tells consumers that the product meets or exceeds CSA's standards for safety and performance.

Deadfront

The property by which a transparent color is visible only when backlit, as when used on keyboard overlays and front panels.

Debossing

The process of lowering a pattern or copy below the original surface.

Decal

A decal or transfer is a plastic, cloth or paper substrate with a pattern printed on it that can be moved to another surface upon contact, usually with the aid of heat or water.

Die Cutting

The process of cutting various shapes to their finished dimensions utilizing a die.

Digital Printing

Digital printing is the reproduction of digital images on physical surfaces. A digital image is simply an image that was created on a computer or has been imaged into a computer readable form. Digital printing does not require physical printing plates or screens allowing for each image to be different, if desired.

Dimensional Stability

The property of a material to resist changes, under varying environmental conditions, in its length, width, or thickness.

Doming

Doming is the process of applying a bubble of plastic over the top of another surface. Doming is typically done with clear, flexible urethane or epoxy resin to protect the image underneath and add a glossy 3-dimensional dome.

Ductility

The property that permits permanent deformation of a metal before fracture by stress under tension.

Durometer

Durometer is one of several ways to indicate the hardness of a material, defined as the material's resistance to permanent indentation. The term durometer is often used to

refer to the measurement, as well as the instrument itself. Durometer is typically used as a measure of hardness in polymers, elastomers and rubber.

Dwell Time

The length of time in which pressure is applied to a pressure-sensitive label during production or application. The time that a pressure sensitive material remains on a surface before it is tested for adhesion or removability. Dwell time is also used to describe the period during which a hot stamping die or embossing head remains in contact with the surface of a label material. Sometimes referred to as contact time.

Embossing

A technique used to raise a pattern of copy above the original surface using matched male and female dies.

Epoxy

A tough synthetic resin that sets with time, heat or pressure, and contains epoxy groups. Epoxy is used in adhesives and surface coatings.

Face Stock

Any material, including paper, film, fabric, laminated or solid foil, suitable for converting into pressure sensitive label stock.

Fatigue Limit

The maximum stress that a metal will withstand without failure for a specified number of cycles of stress. Usually synonymous with endurance limit.

Fisheye

A crater in a coating, usually round with a speck in the middle, thus resembling a fish eye.

Flexibility

The property which indicates how various materials will conform to curved surfaces, measured under specific conditions.

Flexographic Printing

A method of rotary printing utilizing flexible rubber plates and rapid drying fluid inks.

Halftone

A print in which dark and light tones are represented by dots of varying sizes in relationship to the tones or shades which they must portray. Small dots form light tones, larger dots form darker tones.

Hard Tooling

Class "A" tooling which is usually used when material thickness is over .020 (.508mm), to cut tight dimensional tolerances less than +.005" (.127mm), and on large volume production runs. Hard tooling consists of male and female die halves.

Hot Stamping

A method of printing which uses hot metal type plates to imprint ink from a ribbon carrier onto a pressure sensitive film or product surface.

Hygroscopic

The quality of some materials to absorb moisture.

Indigo

Indigo is the name given to a series of digital offset printing presses made by Hewlett-Packard in Israel.

Inkjet Printing

Inkjet printers are a type of computer printer that operates by propelling tiny droplets of liquid ink onto paper or other substrates.

Jig

Any special form or construction which supports a part in position during printing or converting. Also referred to as a fixture or fixturing.

Label

A printed identification denoting contents, ownership, directions, destination, ratings, etc., that can be applied to any object.

Laminate

To apply one layer of a material over another.

Lithography

A printing process using a plate on which only the image to be printed takes up ink. The nonprinting area is treated to repel ink.

Magnetic Die

A thin, flexible, steel cutting plate that is held onto a base cylinder magnetically.

Matrix

An enclosure within which something originates or develops. Also used to describe the weed area surrounding printed and die cut parts.

Matte

A dull finish or surface that reflects a minimum of light. In some applications it allows a surface that can be written on.

Melamine

A typically hard thermoset plastic, based on resins of melamine and aldehyde..

Memory

The property of a plastic material that causes it to return to its original size, after being stretched or distorted.

Metalized Film

A plastic film that has been coated on one side with a thin layer of metal.

Mil

A unit of length equal to one thousandth of an inch; used to specify thickness.

Mil Spec

An abbreviation for “military specification.”

Moiré Pattern

A moiré pattern is an interference pattern created, for example, when two grids are overlaid at an angle, or when they have slightly different mesh sizes.

Moire patterns are often an undesired artifact of images produced by various digital imaging and computer graphics techniques, for example, when scanning a halftone picture or ray tracing a checkered plane. This cause of moiré is a special case of aliasing, due to undersampling a fine regular pattern.

Munsell Color System

A uniform color measurement system or scale, usually used in conjunction with a spectrophotometer.

Nameplate

An identification plate, usually metal or plastic, that can be engraved, etched, embossed or screen printed, and then affixed to a machine or device. Nameplates are distinct from name tags. Name tags tend to be worn on uniforms or clothing whereas name plates tend to be mounted on doors, walls, desktops, or equipment. Name plates are also distinct from name plaques. Plaques are items of larger dimensions that are designed to communicate more information than a name and title.

Nested Layout

Nest – A set of things that fit one inside the other

.

Offset

A printing process utilizing an ink impression made on a rubber cylinder, and transferred to the substrate being printed.

Pantone Matching System

One of the most common color matching systems, often referred to as PMS. It is a standard used by most printers as a guide for selecting and matching the color specified. There are over 530 color variations.

PDF

Portable Document Format (PDF) is an open file format created by Adobe Systems in 1993 and is now being prepared for submission as an ISO standard. It is for representing two-dimensional documents in a device-independent and resolution-independent fixed layout document format. This feature ensures that a valid PDF will appear exactly the same regardless of its origin or destination.

Peel Adhesion

The force needed to remove a strip of pressure sensitive material from a surface. Measured at a specific rate of removal and at a specific angle from the surface.

Pinholing

The appearance of small holes in a solid printed area due to the ink failing to form a complete film.

Plasticizer

A substance added to plastic materials to enhance flexibility and workability.

Polycarbonate

A versatile film that exhibits excellent clarity, stability, printing and die cutting characteristics, as well as good solvent resistance. Used often for panel, overlays, and keyboards.

Polyester

A versatile film used for decal face stocks . It is available in a variety of thicknesses, and in clear, matted, pigmented, metallized, brushed metallized, or transparent colors. Exhibits clarity, stability, abrasion resistance, solvent resistance, good print and die cutting characteristics, as well as good exterior durability.

Polyethylene

A plastic film available in various densities and thicknesses. Generally used in applications where heat resistance and exterior durability are not required.

Premasking

The application of a protective paper or film to the surface of a substrate for protection.

Pressure Sensitive

A tacky adhesive that can be applied to sheet material to enable the sheet to be adhered to an unrelated surface by contact and light pressure without the use of water or solvent.

Proof

A printed impression of the original copy produced for the final verification of spelling, type size, color, etc. Usually a client must sign off on the proof, and the printer keeps the final approval on file.

Register

The exact corresponding placement of successively printed images, and/or a die cut, etc.

Relative Humidity

The ratio of the amount of water vapor in the air at a given temperature to the maximum amount of water vapor air can hold at the same temperature.

Release Liner

A material that has been specially treated which protects a pressure sensitive adhesive. It comes in varying thicknesses, and it allows for easy removal from the adhesive prior to application.

Resin

A solid or semi-solid material of vegetable origin, or obtained synthetically by solvent extraction, that can be dissolved to a liquid state suspended in a vehicle to make an ink or coating, and that, upon drying, forms the solid part of the dried printed form.

Reverse Printing

The printing of a background in a specific color, thus leaving the nomenclature or verbiage the color of the original substrate being printed.

RFID

Radio Frequency Identification (RFID) is an automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags or transponders. An RFID tag is an object that can be attached to or incorporated into a product, animal, or person for the purpose of identification using radio waves. Chip based RFID tags contain silicon chips and antennae. Passive tags require no internal power source, whereas active tags require a power source.

RoHS

The Restriction of Hazardous Substances Directive (RoHS) was adopted in February 2003 by the European Union. The RoHS directive took effect on July 1, 2006, but is not a law; it is simply a directive. This directive restricts the use of six hazardous materials in the manufacture of various types of electronic and electrical equipment. In casual conversation, it is often pronounced “ROSH”, or “Row Haws”, except in Europe, where it is pronounced “Rose”.

Rotogravure Printing

Rotogravure (gravure for short) is a type of intaglio printing process, in that it involves engraving the image onto an image carrier. In gravure printing, the image is engraved onto a copper cylinder because, like offset and flexography, it uses a rotary printing press. The vast majority of gravure presses print on reels of paper, rather than sheets of paper.

Rubber Blanket

Used in offset lithography printing where the image being printed is transferred first to a soft rubber cylinder from the plate, and then onto the substrate. The soft rubber surface of the ‘blanket’ creates a clear impression on a wide variety of smooth and rough materials with a minimum of press preparation .

Scoring

The marking of lines on a substrate. In printing this facilitates an easy fold on a thick substrate to avoid splitting. Cutting through the release liner to create a split backing is also referred to as scoring.

Service Temperature

The range of temperature that a pressure sensitive label will withstand. Often referred to as “exposure temperature”.

Screen Printing

A commercial, artistic, and industrial printing technique which involves the passage printing ink through a taught fabric to which a refined stencil has been applied. The stencil openings determine the form of the imprint. Screen printing has the advantage of being very colorfast and allows for large areas to be covered with a consistent spot color. Screen printing has the disadvantage of being more expensive in large volumes and offers poor image quality for small images and gradients.

Serigraphy

Another name for screen printing

Shear Adhesion

The force required to pull a pressure sensitive label or material from a standard flat surface. The pull direction is parallel to the surface to which the pressure sensitive item has been attached.

Shelf Life

The length of time a product can be stored and remain suitable for use.

Slip Sheeting

The placing of a piece of paper, tissue, or some other material between parts to protect against scratching, sticking, or blocking.

Solvent

A dissolving or thinning agent.

Spot Color

A spot color is any color generated by an ink that is printed using a single run. Liquid inks that are blended together to create a single solid color are also considered “spot colors”. Inks that are printed in various dot patterns to create the perception of a color are called “process colors.”

Steel Rule Die

A cutting die made by shaping ribbons of steel to desired contours and embedding the shapes into a wooden or plastic base with the sharp edges of the steel ribbons exposed.

Step and Repeat

A technique of repeating a single image exposure onto photosensitive material through a negative or positive as may be required, in accurately arranged and spaced increments, to obtain multiple exposures of the same design on a single sheet of film.

Sticker

One that sticks, as a gummed or adhesive label or patch. An adhesive label or sign bearing a design, political message, etc., for sticking on a car's window.

Stress Corrosion

Metal that has been formed into a part while under stress may begin to corrode in areas that have high stress points.

Subsurface Printing

Printing on the underside of a film, usually a transparent film. The ink will then be between the film that was printed and the substrate to which it is applied. Also known as "second surface" printing.

Substrate

The base material upon which printing is done.

Surface Energy

Surface energy refers to the amount of molecular attraction a liquid has to a surface vs. surface tension; which is the phenomenon of a liquid being attracted to itself and beading into drops when on a surface. Untreated metals tend to have high surface energy (HSE). A Teflon frying pan has low surface energy (LSE) creating a low-stick surface. A freshly waxed car also has LSE noticeable by the large fat beads of water that can form on the surface.

Surface Tension

Surface tension is the force exerted along the surface of a fluid that causes it to "bead up" and form into drops. Water has high surface tension and beads up easily; alcohol has low surface tension and does not often show droplets.

Tack

The ability of an adhesive to adhere to a substrate with only a minimum of pressure.

Tag

A small piece or strip of cloth, paper, plastic, or other material attached to something, normally by one end, or hung on it as a label or means of identification.

Temper

A condition produced in a metal or alloy by mechanical or thermal treatment, having characteristic structural and mechanical properties.

Transfer Tape

A pressure sensitive adhesive that has release liners on both sides which can be applied to a substrate and then die cut. Transfer tape can also be a self wound tape coated on one side with a removable adhesive that can be laminated over thermal die cut or plotter cut and weeded graphics products such as lettering. The transfer tape can then hold the cut elements in place during removal from their back liner and application to the intended surface. Once applied, the elements adhesive, being more aggressive than the transfer tapes, allows removal of the transfer tape.

UL

Underwriter's Laboratories is a well known testing laboratory located in Northbrook, Illinois that develops standards and test procedures for materials, components, assemblies, tools, equipment and procedures, chiefly dealing with product safety and utility. UL does not "approve" any product. Rather it tests product samples and permits acceptable products to carry the UL certification mark, as long as they remain in conformity with the standards and with the samples tested to those standards. A product with a UL listing is said to be "UL Listed."

Ultimate Adhesion

The maximum bond established between product and the surface to which it is adhered. The time involved varies, but usually ultimate adhesion takes place in 72 - 96 hours. Most pressure sensitive adhesives will reach ultimate adhesion more quickly at a temperature of 150 degrees F. Acrylic adhesives may continue to "cure" for up to one year.

U.V. Drying

A system that employs ultraviolet radiation to rapidly complete the curing process.

Vector Graphic

Vector graphics such as points, lines, curves, and polygons, which are all based upon mathematical equations to represent images in computer graphics. It is used by contrast to the term raster graphics, which is the representation of images as a collection of pixels. Files that are created with vector graphics have the advantage of printing in any size with infinite detail. Vector files are preferred of all logos. Common file extensions are : .ai, .eps, .cdr, and others.

Web Press

A rotary type press that can accept material from roll stock.

Weed

The waste area around a cut label.

Wet Out

The term used when an adhesive makes surface contact and establishes adhesion to the substrate. Also used to describe the flowing out of wet ink.

Wrought Alloy

Metal that is rolled to achieve a specific gauge and hardness.

Yield Strength

The stress at which a material exhibits a specified limiting deviation from proportionality of stress to strain. An offset of 0.2% is used for many metals such as aluminum-base and magnesium-base alloys, while a 0.5% total elongation under load is frequently used for copper alloys.