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POLYMER FUSION VS. TRADITIONAL LABELING:

Regardless of claims made by label suppliers or manufacturers asserting the similarity and durability of their labels as compared to Polymer Fusion labels from Mold In Graphics or Polyfuze specifically for products manufactured of low surface energy polyolefin thermoplastics, it is essential to recognize there are substantial differences between Polymer Fusion and traditional labeling methods (e.g., pressure-sensitive adhesive, hot stamp foil, heat transfer, and in-mold offerings for both injection and rotational molding.)

While each of these traditional methods are considered “finished labels," it is crucial to differentiate Polymer Fusion labels, which are provided in a "raw material" state before undergoing the application or molding cycle, at which stage they are deemed finished.

Construction Method:

a. Traditional Labeling: Multi-layer construction commonly composed of coatings, inks, substrates, and adhesives that are not compatible with polyolefin thermoplastics.

b. Polymer Fusion Labeling: Single-layer construction of pigmented fully polyolefin compatible “polymer ink” suspended on a removable clear carrier film. Unlike traditional labels that use a standard white background substrate to achieve the desired color outcome, Polymer Fusion labels are formulated to integrate directly with the polyolefin thermoplastic product or part color. This integration process creates the final color as intended, meaning the raw material label may appear different before application but will match the product color post-molding or application.

Performance / Durability:

a. Traditional Labeling: Efforts to attain linear adhesion to the product surface are challenged by the low surface energy, inconsistent expansion rates, and outgassing of polyolefin thermoplastics, impacting long-term adhesion and performance.

b. Polymer Fusion Labeling: Accomplishes molecular fusion with polyolefin thermoplastics, seamlessly merging the two without the need for adhesives, tie-layers, or secondary treatments, ensuring a durable and lifelong polyolefin plastic component for the product's entire lifespan.

Sustainability/Recyclability:

a. Traditional Labeling: Incompatible labels are non-recyclable with polyolefin thermoplastics, creating unclean recyclate and generating waste when removed.

b. Polymer Fusion Labeling: Compatible materials enable full recyclability with polyolefin thermoplastics.

PURPOSE:

This document establishes a common label inspection standard for the customers of Mold In Graphic Systems® (MIGS) and Polyfuze® Graphics Corporation (PGC).

A specific subset of these standards, tailored to MIGS and PGCs unique technology, is drawn from the National Association of Graphic and Product Identification Manufacturers, Inc. (GPI). These standards encompass a comprehensive set of guidelines for label inspection. They are designed to foster an objective versus subjective standard during the inspection process, offering customers unequivocal acceptance criteria. The provided inspection standard delivers a precise definition of what qualifies as acceptable, along with the exact conditions under which they apply.

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1.0 SCOPE:

This document is designed for use in the label receiving process (with exception to section 8.3.1 Color, where color verification is conducted from finished product) for screen printed labels produced by MIGS or PGC with label quality assessed through visual inspection. The ultimate determination of a labels acceptability depends on its visual appearance when viewed by the end user under specific guidelines. It's worth noting that minor imperfections may be inherent to the materials and printing processes involved and are deemed acceptable as an overall printing industry practice.

2.0 DEFINITIONS:

Apparent Color Variation – Any unintended variation in the perceived color that is visible under the defined viewing conditions. ***NOTE:*** Raw material polymer fusion labels are typically non-opaque and have been custom color-matched to match specific polyolefin substrate colors. As a result, color verification cannot occur until after the application or molding process on the finished product.

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. Acceptable Quality Level to be used is 1.5 per Mil-Std-105E.

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. Acceptable Quality Level to be used is 2.5 per Mil-Std-105E.

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

Delamination – The condition when the label separates from the substrate prior to application.

Stray Spot - A tiny spot of polymer ink outside the printed label area.

Void – A tiny hole or void in the label that permits light to pass through the printed area.

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

Printing Misregistration – Layers of polymer ink that are not aligned allowing the substrate to show through. This can typically be seen on the label itself or on the product after molding or application.

AQL (Acceptable Quality Level) – A quality control standard used within our manufacturing process to define the maximum acceptable number of defects in a batch. This ensures that each batch meets strict quality criteria before approval.

Sigma Level (Process Performance) – Our manufacturing process consistently achieves a Sigma level between 3 and 4. This indicates that while defects are statistically expected, they are within industry-accepted levels, reflecting a high standard of overall process quality.

3.0 INSPECTOR QUALIFICATIONS:

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

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4.0 COLOR EVALUATION:

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

4.1 Visual: This basic method involves visually comparing colors with a standard color chip. It's quick, simple, and cost-effective but subjective and influenced by light sources. The human eye's perception of millions of colors introduces variability, making precise matches difficult. Enhanced methods like using a viewing booth with standard light sources (e.g., Fluorescent Daylight, Incandescent, Cool White Fluorescent, Ultra-Violet A) can reduce subjectivity but still rely on individual judgment.

4.2 Spectrophotometric: A more accurate and objective approach, involving a spectrophotometer linked to a computer. Popular systems include those by Konica Minolta, X-Rite, and Data Color. They use spectral curves to measure color reflectance, allowing precise color matching and formula generation for ink mixing. This method covers the necessary elements (observer, sample, light source) and removes human variability, ensuring consistency.

4.3 Densitometry: Mainly for process colors, densitometers measure light absorption by ink, helping printers adjust ink amounts or saturation for color accuracy.

4.4 Standards of Comparison: Munsell Color Standard - Organizes color based on hue, value, and chroma, suitable for visual matching and instrument data correlation. Pantone (PMS) - Widely used for identifying specific colors in printing, offering formula guides and color standards. Federal Standard No. 595a - U.S. government standard with general color specifications for visual comparisons. CIE Lab System - Widely recognized for accurate color description and difference equations, using a standard illumination source and observer vision angle for objective measurement. Other Systems - FMC II and Hunter systems offer similar data and calculations to CIE Lab but with different comparison scales.

4.6 Variables

4.6.1 Light Source: A major factor in color perception, with different lighting conditions affecting color appearance.

4.6.2 Gloss and Angle Viewed: Color perception is influenced by the gloss level and viewing angle. The substrate type also plays a crucial role; different materials may lean towards glossiness or a matte finish, which affects how colors are perceived. For detailed properties of each substrate, refer to section 4.5.5.

4.6.3 Observer Variability: Human observers introduce variability in color evaluation, emphasizing the need for standard viewing conditions.

4.6.4 Ambient Colors and Second Surface: Surrounding colors and substrate hue can influence color judgment.

4.6.5 Substrates: The type of substrate (e.g., plastic, metal, composite, other) can significantly affect how colors appear. Each materials unique properties can alter the hue, saturation, and brightness of a color.

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5.0 INSPECTION TOOLS:

5.1 Under this Label Inspection Standard, lables and/or parts are inspected under the prescribed viewing conditions (Section 6.0) with an unaided eye and without the use of backlighting. Once defects are noticed with the unaided eye per the outlined procedure, further inspection tools may be used to determine if a defect is large enough to be considered unacceptable.

5.2 Inspection tools that may be used are:

5.2.1 Digital Calipers

5.2.2 7X Loupe (see section 5.4)

5.2.3 Films with standard defect sizes

6.0 VIEWING CONDITIONS:

6.1 Lighting – Inspection shall be performed under overhead fluorescent lighting producing more than 70-foot candles. ***NOTE:*** The use of light tables or other forms of light from behind polymer fusion labels for quality inspection purposes is prohibited.

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 size covered in section 8.0 and based on chart 1 shown on page 7.

6.3 Viewing Angle - During inspection, parts shall be held at approximately 45 degrees to the horizontal so 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 change during the inspection process.

6.4 Magnification - Magnification shall only be used to confirm the size of defects.

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

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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. Please see section 2.0 for definitions.

8.1 Stray Spots / Voids / Contamination / Minor 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 on page 7 for the size and number of allowable defects.

8.1.3 ***NOTE:*** Any group of extremely small spots that appear as one spot, without magnification, will be evaluated/counted as one defect (spot).

8.1.4 ***NOTE:*** The clear area in a void or fisheye-type defect will determine the size of the defect.

8.1.5 ***NOTE:*** As with all polymer fusion raw material labels, minor voids or defects usually dissappear during the fusion process or application process.

8.2 Scratches

8.2.1 Scratches are defects long in nature and are defined by their length and width.
NOTE: Any group of extremely small scratches that appear as one scratch, without magnification, will be evaluated/counted as one defect (scratch).

8.2.2 See Chart 1 on page 7 for the size and number of allowable defects.

8.3 Color Variation / Streaks

8.3.1 Color variation shall be held within the limits below (see a and b):
NOTE: Color verification is not to be conducted on raw material polymer fusion labels. It's important to first conclude the application or molding process. Raw material polymer fusion labels are semi-opaque polymer inks printed on a transparent carrier film that have been custom color-matched to a customer's specific polyolefin product color, not a standard white label substrate as used on many traditional labeling methods. While every effort is made to achieve an exact color match to customer specifications, the final color may exhibit slight variations when using color measurement equipment. Even official color formula guides, such as Pantone or RAL, utilize semi-translucent colors printed on a white substrate, allowing for acceptable ranges of variation. More information about color variation can be found at www.pantone.com/articles/technical/challenge-variations-in-print

a) Color limits initially set by the customer (color chips or color chart) with understanding about polymer fusion ink color variation. Color limits will be developed by label supplier and approved by the customer. A "Standard color match" shall be a close color match to the customer's color sample or call out. 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.

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b) Color variation of polymer fusion color on finished product 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.

8.3.2 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.

8.4 Screen Print Lettering / Characters / Borders

8.4.1 No defects (spots, smears, missing letters, etc.) that affect the meaning, intent or legibility of the part are allowable.

8.4.2 Imperfections in characters, lettering and borders shall be no greater than .020".

8.4.3 Color shadowing or "ghosting" shall not be visible at 18 inches under the prescribed viewing conditions.

NOTE: The label supplier bears no responsibility for uncorrected errors, whether graphical, textual, color-related, or other, in artwork provided by customer as approved and printed as a label.

8.5 Delamination

8.5.1 Minor delamination (≤ 1.5mm) of polymer ink from carrier film is normal and may be visible. Any major delamination apparent at 18 inches under the prescribed viewing conditions is cause for investigation.

8.6 Screen Print Registration (color-to-color)

8.6.1 Minor color-to-color misregistration of printing visible from 18 inches under the prescribed viewing conditions is permitted as they generally disappear during the fusion process. Screen printing to screen printing (color to color) acceptable tolerance is ±0.25 mm (.010")

8.6.2 Edges of die-cut pieces will not show feathering (strings) visible at 18 inches.
NOTE: The purchase of die-cut tools, including replacements for worn-out tools, is the exclusive responsibility of the customer. Customers who opt not to replace these tools, even when strongly recommended by the label supplier, waive their right to inspection in this regard.

8.6.3 Edges of die-cut pieces may show minor delamination (≤ 1.5mm) of polymer ink from carrier film. Any major delamination apparent at 18 inches under the prescribed viewing conditions is cause for investigation.

8.7 *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.

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9.0 DEFECT CHARTS AND PICTORIALS:

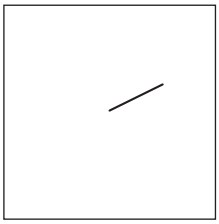
Chart 1 (Size and Number of Allowable Defects per Part)			
Part Class (see Section 2.0 Definitions)	**Length x Width Or Total Cumulative Diameter**	**Maximum Number of Part Defects per Square Inch**	**Maximum Number of Part Defects per Three Square Inches**
A	**.25" Long x .003" Wide or .020" diameter**	**1**	**2**
B	**.50" Long x .003" Wide or .040" diameter**	**2**	**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.

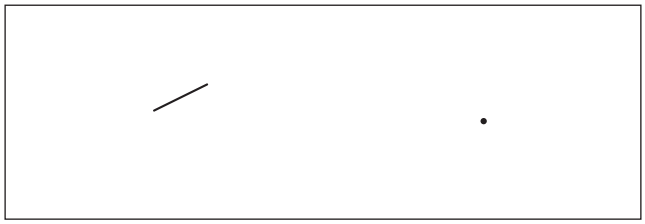
Pictorial A below shows examples of the allowable defects for a Class A part based on Chart 1 above. The one-square-inch and the three-square-inch boxes show the approximate size of the areas used to determine the number of defects per prescribed area. As seen in the pictorials below, the allowable number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

One Square Inch



Three Square Inches



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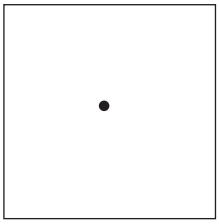
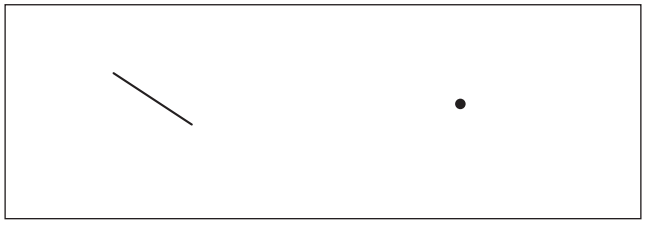
Pictorial B (Example of Allowable Defects for Class B part based on Chart 1 above)

One Square Inch

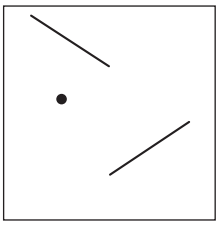


Three Square Inches

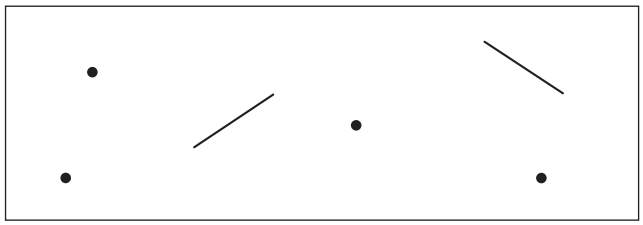


Pictorial C (Example of Allowable Defects for Class C part based on Chart 1 above)

One Square Inch



Three Square Inches



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10.0 POLYMER FUSION RAW LABEL DELIVERY EXPECTATIONS

The purpose of this section is to clearly outline the quality expectations and standards for Polymer Fusion raw labels upon delivery. It aims to inform customers about the quality control measures we implement, including our adherence to AQL standards and our Sigma level achievements. This section also sets realistic expectations regarding acceptable defects in line with industry standards and clarifies the conditions under which defects will be addressed. By providing this information, we seek to foster transparency and mutual understanding, ensuring that our customers are fully informed of the quality they can expect and the protocols in place for handling any issues.

10.1 Polymer Fusion Raw Label Delivery Expectations

10.1.1 Quality Assurance: We are committed to delivering high-quality Polymer Fusion labels. Our manufacturing process incorporates AQL (Acceptable Quality Level) standards and other quality initiatives to ensure that each batch meets stringent inspection criteria. These effort reflect our dedication to providing products that align with industry standards for quality and reliability.

10.1.2 Expected Defects: According to the American Society for Quality (ASQ) on Six Sigma, in the manufacturing industry, the standard Sigma level typically ranges between 2 and 3, which corresponds to 66,800 to 308,500 defects per million opportunities (DPMO). This means that a certain level of defects is considered acceptable across the industry.

In comparison, our manufacturing process consistently achieves a higher quality level, operating between a Sigma level of 3 and 4. At this level, you can expect significantly fewer defects—approximately 6,210 defects per million opportunities (DPMO). While we strive for perfection, minor defects are statistically expected and are within industry standards. These acceptable defects are inherent to the production process and must be accepted by the customer. The presence of such defects does not warrant a refund or replacement.

10.1.3 Issue Resolution: In the rare event that a batch of labels falls outside of our established AQL standards, resulting in defects that exceed acceptable levels, we will take prompt action to rectify the issue. This may include the replacement of the defective labels at no additional cost to the customer. Our goal is to ensure your complete satisfaction while maintaining realistic expectations grounded in industry practices.

10.2 Understanding Expected Quality for Your Order

To help you gauge what to expect from your custom order, here's a straightforward way to estimate:

- **For Smaller Orders (e.g., 500 labels):** At our Sigma level, you might see 3 to 5 *minor defects.
- **For Larger Orders (e.g., 5,000 labels):** Expect around 30 to 50 *minor defects.

These estimates are based on industry standards and reflect the high level of quality we aim to deliver. And as we strive to achieve perfection, a small number of defects is normal per industry standards and within acceptable limits.

*The types of defects you might encounter must be defined according to our Inspection Standard, which outlines acceptable defects based on the classification of the label (e.g., Class A, B, or C). This ensures that any defects present are within the boundaries of what is considered acceptable for your specific label classification, and also defines what constitutes a defect outside of the acceptable range. Additionally, the number of defective labels outside of this acceptable range that would necessitate re-manufacture under our warranty guidelines is clearly specified.

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11.0 STORAGE REQUIREMENTS FOR RAW LABELS AND WARRANTY CLAIMS

To ensure the longevity and quality of your Polymer Fusion raw labels and to maintain the validity of our warranty, it is crucial to adhere to our specified storage conditions. Improper storage can lead to damage, such as cracking, delamination, or other forms of deterioration that render the labels unusable.

11.1 Proper Storage Conditions

To protect your labels and avoid any issues, please follow these storage guidelines:

- **Temperature:** Store labels in a controlled environment with a temperature range between 10°C and 35°C.
- **Avoid Pressure and Stacking:** Do not press or stack items on top of the label rolls.
- **Avoid Direct Sunlight:** Keep labels away from direct sunlight to prevent UV damage.
- **Manufacturing Environment:** Even when labels are in use within a manufacturing environment, they must still be stored according to these guidelines to prevent damage.

Failure to comply with these storage requirements will void the limited warranty. If a claim is to be made, it must be supported by evidence showing compliance with these storage conditions. The Purchaser must provide written notice to MOLD IN GRAPHIC SYSTEMS® within 12 months of the label's manufacture date, including relevant details such as the Item Code, Item Description, PO Number, and ID Number from the packaging delivered to purchaser. For complete storage guidelines and warranty information, please refer to our Warranty Page at https://moldingraphics.com/wp-content/uploads/2023/10/10-12-23_Mold-in-Graphic_Warranty-101223-1.pdf

12.0 POST MOLDING / POST APPLICATION INSPECTION

This section establishes the standards for inspecting Polymer Fusion labels after they have been molded or applied to the final product. Unlike traditional labels, Polymer Fusion labels undergo a fusion process during molding or application, necessitating a distinct set of inspection criteria post-process.

12.1 Inspection Timing

Initial Inspection: Should be conducted immediately after the molding or application process while the product is still within the production line and once the product has cooled.

12.2 Visual Inspection

12.2.1 Inspect the labels under the same lighting conditions outlined in section 6.1 (overhead fluorescent lighting producing more than 70-foot candles).

12.2.2 The viewing distance and angle should remain consistent with the pre-application inspection standards to ensure uniformity.

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12.3 Inspection Criteria

12.3.1 Fusion Quality: The label should be fully integrated into the surface of the product. This can be assessed by performing a tape test using proper 893 Scotch Tape or Permacel 99 without cross-hatching. The label should not peel or lift under the tape, indicating successful fusion with the substrate.

12.3.2 Color Uniformity: Polymer Fusion labels are not constructed using standard white background substrates as found in traditional labeling, where colors are then laid down on the white to produce the desired outcome. Instead, Polymer Fusion labels are strictly pigmented polymers formulated to integrate with the polyolefin thermoplastics product or part color to create the desired outcome. While the raw material label may appear different prior to molding or applying, once the process is complete, the color of the part along with the color of the label integrates to create the desired outcome and color requested. Any significant post-molding or post-application discoloration or deviation from the approved color sample should be noted and addressed.

12.3.3 Defects:

Defect Chart Reference: The same defect chart used for pre-inspection of labels should be referred to for post-molding or post-application inspection. The acceptable range of defects depends on the product class (A, B, or C) and the type and amount of defects listed in the chart.

Bubbles or Voids: Check for the presence of bubbles or voids that may have developed during the fusion process. These defects are typically caused by trapped air, unclean molds or parts, or improper application and shall not be visible at 18 inches under the prescribed viewing conditions.

12.4 Suitability on Products

Polymer Fusion labels are provided on the basis that any Purchaser or Customer has independently determined the suitability of the Products for the Purchaser's purposes. This suitability includes ensuring that the labels meet the durability and performance requirements necessary for the specific application. The responsibility for verifying that the labels satisfy these criteria, as well as conducting the appropriate inspection and performance testing, lies solely with the Purchaser.

13.0 REFERENCES:

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

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