ADHESIVE GUIDE

We do not sell adhesives. We use the adhesives below to construct products for our customers.

Pressure sensitive adhesives adhere to a variety of substrates when applied with pressure. The primary mode of bonding for a pressure sensitive adhesive is not chemical or mechanical but polar attraction to the substrate surface. Applied pressure is necessary in order to achieve sufficient wet-out onto the substrate surface to provide adequate adhesion.

MANUFACTURING PROCESS:
Several manufacturing processes are used to manufacture pressure sensitive adhesives. They include solvent-based, hot-melt, and emulsion processes.

1. Solvent: In solvent-based processes, adhesive ingredients are dissolved in solvent solution and applied to a web of material. After coating, the solvent dries out, leaving the adhesive.

2. Hot Melt: In hot-melt processes, thermoplastic rubbers are formulated with tackifying resins, oils, and antioxidants. The adhesive is coated onto a web of material at temperatures exceeding 300F.

3. Emulsion: In emulsion techniques adhesive ingredients are emulsified in water, applied to a web, and then dried.

ADHESIVE FORMULATIONS:
Adhesives are derived from rubber-based, acrylic, modified acrylic, and silicone formulations. Each formulation displays distinct performance characteristics.

1. Rubber-Based Adhesives: These adhesives are synthetic, non-latex rubbers formulated with tackified resins, oils, and antioxidants. They provide good to excellent initial tack and adhesion particularly to low-surface-energy materials such as plastics. They do not demonstrate good temperature resistance (typically <150°F) or resistance to solvents, sterilization, chemicals, or ultraviolet rays. Some rubber-based adhesives are specially formulated to achieve exceptional adhesion in high-moisture applications.

2. Acrylic Adhesives: Based on acrylic polymers, acrylic adhesives provide resistance to solvents, UV light, elevated temperatures, plasticizers, and chemical reagents. They tend to be more costly than

rubber-based varieties, but provide better long-term aging and environmental resistance. They have low to moderate initial tack and adhesion, and generally do not adhere well to low-surface-energy substrates.

3. Modified Acrylic Adhesives: Formulated from acrylic polymers but incorporating additional components found in rubber-based systems, modified acrylics offer improved initial tack and adhesion to low-surface-energy materials compared with non-tackified acrylic formulations. The modifiers decrease resistance to solvents, plasticizers, and UV light. Shear properties and temperature resistance are also reduced. While modified acrylics gain tack and adhesion, the trade-off is a loss of internal strength and environmental stability.

ADHESIVE COMPARISON CHART

FEATURE	ACRYLIC	MODIFIED ACRYLIC	RUBBER BASED
Adhesion	Medium to High	High	Medium to High
Cost	Medium to High	Medium to High	Lowest
HSE Plastics*	Excellent	Excellent	Excellent
LSE Plastics*	Poor	Moderate	Excellent
Plasticizer Resistance	Good	Moderate	Poor
Shear	Medium to High	Low	Medium to High
Solvent Resistance	Medium to High	Low to Moderate	Poor
Tack	Low to Moderate	High	Medium to High
Temperature Resistance	Medium to High	Low to Moderate	Low
UV Resistance	Good	Poor	Poor

*HSE: High Surface Energy Plastics: HDPE, PET, PETE, Vinyl, and Polypropylene
*LSE: Low Surface Energy Plastics: LDPE, Polystyrene, Teflon, Rubber (latex)

CHOOSING AN ADHESIVE: The choice of an adhesive is based upon the use of the label and the environment in which it is applied and used. The following elements are crucial in determining the correct adhesive selection. **As with all label applications, testing is recommended before finalizing a decision.**

1. Surface Contour: The contour of the object to which the label is applied a primary consideration. Where irregular angles are involved, more flexible face stocks should be used. Regardless of the adhesive strength, it is virtually impossible for an adhesive to overcome continuous stress placed on it by a rigid or stiff label material attempting to return to its original condition. This is referred to as stock "memory". In such applications, a more conformable face stock should be chosen.

2. Surface Energy: This is a measure of how well an adhesive wets out over the surface of the material to which it is applied. Materials with low surface energy (LSE) do not allow adhesives to wet out, while materials with high surface energy (HSE) provide excellent wet-out, providing the best

adhesion. Rubber-based adhesives usually provide better adhesion to LSE surfaces. Some substrates require special treatment such as corona treating, primers, top coating, etc., in order to achieve better adhesion. On some LSE substrates, adhesion levels improve the longer adhesive is applied.

3. Surface Contamination: The presence of contamination such as dust, paper debris, oils, etc. on the surface of the substrate can prevent contact of the adhesive with the substrate. Many types of surface contamination are not visible but can be identified analytically. It may be necessary to clean the surface in order to obtain an acceptable bond.

4. Surface Texture: The texture of a substrate can impact the adhesive bond. Textured materials do not allow complete contact of the adhesive with the substrate. Less surface contact results in a smaller bonding area and lower adhesion levels. Where substrates have texture, more aggressive adhesives are recommended.

EVALUATING ADHESIVES:

There are a group of standard measures to evaluate adhesive performance. They include shear, tack, and adhesion.

1. Shear: Shear is a measure of the internal or cohesive strength of the adhesive, not a measure of the bond between the adhesive and a substrate. Usually, tack and adhesion performance decreases as shear strength increases.

2. TACK: Tack is a measure of the force required to remove the label and adhesive from the substrate. It usually refers to the measure of initial attraction of the adhesive to the substrate. The degree of tack is a function of adhesive components. It can be and is controlled by manufacturers to create different products based upon end user requirements.

3. Adhesion: This measures the bond strength between an adhesive and a substrate after pressure is applied to the adhesive and after allowing for wet-out onto the substrate (adhesive set up). The degree of adhesion can be and is controlled by manufacturers to create different products based upon end user requirements. Adhesion will continue to increase for a period of time from the moment of application, typically 24 hours.

4. Cold flow / ooze / Bleed: Bleed/Bleed Through: The migration of components from the adhesive or substrate onto the face material, resulting in its mottled appearance and possible dysfunction of the adhesive. Cold Flow: The viscous flow of a pressure sensitive adhesive under stress

TYPES OF ADHESIVES:

1. Permanent Adhesives: Permanent adhesives are typically specified for most applications. They display good bonding characteristics and withstand most environmental conditions; however performance depends on the surface to which they are applied.

- **Permanent, acrylic:** Excellent adhesion to paper, painted metal, glass, and high surface energy plastics. Not recommended for textured surfaces, wax cartons, porous surfaces, or low surface energy plastics. See Adhesive Chart (# 2).

- **Permanent, aggressive:** Typically a rubber based permanent or modified acrylic based permanent. This adhesive is very aggressive and is difficult, if not impossible, to remove. They perform well on corrugated, paper, painted metal, glass, flat surfaces, and/or difficult substrates or challenging conditions. See Adhesive Chart (# 1).
- **Permanent, block out:** This is an aggressive high tack permanent adhesive with a special opaque barrier coating that allows the label to be applied over existing labels for correction. This barrier coat prevents bar codes on the original label to be inadvertently scanned through the top correction label. See Adhesive Chart (#58).
- **Permanent, all temperature:** See permanent, cold temperature.
- **Permanent, cold temperature:** A special adhesive that can be applied to surfaces at temperatures as low as -20F. It has good initial tack and high ultimate adhesion. It performs well on low surface energy plastics and has good permanency at temperatures from -65F to 160F. FDA compliant for indirect food contact. See adhesive chart (# 11).
- **Permanent, food contact:** An adhesive designed to adhere to fresh fruits and vegetables with edible skins. Good initial tack and adhesion. Meets FDA 21 CFR 175.105 and FDA 21 CFR 175.125(b). Does not meet the requirements for FDA 21 CFR 175.125 (a) for direct food contact. See Adhesive Chart (#16).
- **Permanent, freezer:** See permanent, cold temperature
- **Permanent, glove friendly:** This is an acrylic adhesive having high initial tack, high shear, and high ultimate adhesion. It performs well on small diameter surfaces. It has minimum cold flow. It is UL approved and compatible with latex gloves. See Adhesive Chart (# 6).
- **Permanent, high heat resistance:** A permanent, high performance, acrylic based adhesive featuring high ultimate peel values. Service temperature range exceeds 300-350F. Appropriate for use with polyimide and polyvinyl fluoride film facestocks used in printed circuit board manufacturing (resists edge attack by solvents and chemicals used in this production environment). See Adhesive Chart (# 40).
- **Permanent, non ooze:** An acrylic permanent adhesive with non-oozing properties. Designed for use in heat fusion printers like laser printers. This adhesive allows exact size manufacturing of label without concern for adhesive recession on the liner. See Adhesive Chart (# 63).
- **Permanent, repulpable:** This adhesive offers excellent tack and adhesion to corrugated and paper substrates. It has moderate adhesion to non-polar substrates. The key feature of this adhesive is it is dispersible. It is a terrific solution for water wash-off label applications such as recycling. It meets TAPPI standards for re-pulpability. See Adhesive Chart (# 41).
- **Permanent, rubber based:** An outstanding general-purpose permanent adhesive, which has high initial tack and high ultimate adhesion. Application temperature +25F. Service temperature range: -65F to +220F. FDA approved for indirect food contact. Superior performance on corrugated, paper, painted metal, glass, and packaging film. Works well on curved surfaces. See Adhesive chart (#1).
- **Permanent, textile:** Designed specifically for sock band and other textile label applications. Not recommended for application to silk fabric. See Adhesive Chart (#42).
- **Permanent, tire label:** A highly aggressive permanent adhesive designed specifically for tire label applications. It has high initial tack, shear, and ultimate adhesion. It provides excellent performance on hard to label substrates such as wood and carpet backing. See Adhesive Chart (# 4).
- **Permanent, tight diameter:** See permanent, glove friendly.
- **Permanent, water-soluble:** A permanent adhesive that is removable in 100F water. It has good initial tack and ultimate adhesion, and allows consumers or recyclers to remove the label using

warm water. It also is effective when labels have been misapplied to containers. See Adhesive Chart (# 37).

- **Permanent, UL:** A general-purpose permanent adhesive designed for UL type L applications. Used in drug test label applications. See Adhesive Chart (#44).
- **Semi-permanent, freezer:** An adhesive with good initial tack and ultimate adhesion. Can be applied at temperatures as low as -20F. Semi-permanent on most surfaces at room temperature and above. Not recommended for small diameter surfaces. Complies with FDA for indirect food contact. Minimal cold flow adhesive, good for fan fold applications. See Adhesive Chart (# 9).

2. Removable Adhesives: When removed, the label will detach in one piece leaving little or no adhesive residue. Each removable application requires thorough testing to be sure the adhesive and surface are compatible. Usually a removable adhesive is recommended when a label has a short-term life or is applied to a surface that could be damaged by the adhesive. Longer-term removable adhesives are available.

- **Removable, cold temperature:** A removable acrylic adhesive having good tack and adhesion performance combined with superior removability, even at low temperatures. Minimum application temperature +5F. FDA compliant for indirect food contact. See Adhesive Chart (#45).
- **Removable, high initial tack:** A general-purpose removable adhesive with high initial tack, internal strength and stable adhesion. Removes cleanly from most surfaces, with the exception of HDPE. It is FDA compliant for indirect food contact. See Adhesive Chart (#48).
- **Removable, laser:** A special acrylic adhesive having good tack and adhesion characteristics as well as superior removability. Laser printer qualified. FDA compliant for indirect food contact. See Adhesive Chart (#46).
- **Removable, long term:** A general-purpose removable adhesive featuring moderate tack and clean removability from many substrates for up to 6 months. See Adhesive Chart (#49). It is also available in ultra removable. See Adhesive Chart (#50).
- **Removable, Ultra:** A removable adhesive with ultra low tack, adhesion, and shear properties. It has a service temperature range of -20F to +250F, and is removable without leaving residue. See Adhesive Chart (#55).

3. Repositionable Adhesives: Similar to removable adhesive. By definition, repositionable allows a label to be removed from a surface and applied again to the same or different surface without losing its effectiveness or leaving residue. This feature is desirable in situations in which a label has been misapplied. It needs to be removed and reapplied, after which greater adhesion is desirable. Adhesives with low or moderate initial tack serve this purpose. There are a number of removable adhesives that have moderate initial tack and good adhesion that may qualify for this purpose, however they are dependent on the surface to which the label is applied. Testing is recommended.

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