Dual Lock™ Reclosable Fasteners
Roll Goods Design Criteria

Technical Bulletin **March, 2007**

Introduction

3M™ Dual Lock™ Reclosable Fasteners are comprised of continuous thick film backing with stems protruding from one side of the backing. The self supporting flexible stems have mushroom shaped heads. The base film, the stems and mushroom heads are manufactured from polyolefin materials. Three types of Dual Lock reclosable fasteners (type 170, type 250 and type 400), refer to the approximate number of stems per square inch. A product constructed with similar materials and configuration but much thinner is 3M™ Dual Lock™ Low Profile Reclosable Fastener which has approximately 705 stems per square inch.

Dual Lock reclosable fasteners can be engaged in the following combinations of increasing strength: type 170 to type 250, type 170 to type 400, type 250 to type 250 and type 250 to type 400. Dual Lock reclosable fasteners and Dual Lock low profile reclosable fasteners can also engage with many loop materials, such as 3M™ Scotchmate™ Reclosable Fasteners Loop. This combination allows a quick grab closure with high strength, but reduced cycle life. We do not recommend that standard height Dual Lock reclosable fasteners be engaged with Dual Lock low profile reclosable fasteners as performance characteristics have not been well studied.

When two pieces of Dual Lock reclosable fasteners are pressed together, the stems flex and the mushroom heads slide past each other. After passing the mushroom heads on the opposing mating piece, the stems snap back into their original position, interlocking with the mushroom heads on the opposing piece. The audible SNAP indicates engagement has occurred. This provides a strong reclosable attachment system. These Dual Lock reclosable fasteners can provide high tensile strength but the Dual Lock reclosable fasteners can easily be opened by simply cleaving or peeling open the closure.

Dual Lock reclosable fasteners can reduce the number of, or replace, conventional fasteners such as screws, clips, rivets, snaps and bolts in many applications. This product is well suited to many applications where a high strength, reclosable fastening system is required. Many Dual Lock reclosable fastener products have good performance even after exposure to ultraviolet radiation, high moisture levels and wide temperature ranges up to approximately 220°F (105°C). Refer to specific technical data pages for product performance under various temperature, weight and loading conditions.

Dual Lock reclosable fasteners have many options for attaching to various surfaces and materials. The table in the installation and attachment needs section summarizes the backing options available and methods commonly used for attachment.

Important Notice:
All physical properties, statements, and suggested procedures are based on tests 3M believes to be reliable or based on our product experience. There are many factors that can affect the use and performance of a 3M product, some of which are uniquely within the user's knowledge and control. It is essential that the user evaluate the chosen 3M product(s) to determine whether it is fit for a particular purpose or suitable for the user's method of application.

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Design Considerations

The following information is intended to assist the designer considering the use of 3M™ Dual Lock™ Reclosable Fasteners for various applications. Ultimate product performance depends upon a number of factors, including 1) The characteristics of the chosen Dual Lock reclosable fasteners, 2) The material to which the Dual Lock reclosable fasteners is applied, 3) Usage requirements including the environment in which it is expected to perform, and 4) Installation procedures and methods. These major factors are discussed in greater detail below. Having answers to these questions will help in more quickly narrowing the list of products to consider for a particular application. Your local 3M sales representative can help suggest the Dual Lock reclosable fasteners meeting your needs. Because many of these factors are uniquely within the end user's knowledge and control, it is required that the user fully evaluate 3M products to determine whether they are fit for a particular purpose and suitable for the user's materials, method of application or desired end use.

Fastener characteristics and requirements:

Choosing the correct Dual Lock reclosable fastener to meet your final requirements is critical to a successful design and properly functioning application. Reviewing the various options below will help in deciding the type of Dual Lock reclosable fastener to select for evaluation in your application.

Special requirements or specifications:

Often there is a need to meet certain product performance requirements, such as flammability, out gassing under vacuum environments, disinfecting, etc. Additionally there may be specific government, industry or customer specific requirements or standards. A thorough understanding of the performance requirements, specifications or standards can assist in narrowing your list of products to consider.

Amount to Use:

As a general rule, four square inches of engaged Dual Lock reclosable fastener area per pound (57.3 sq. cm per kilogram) of static load being supported is suggested as a starting point for evaluation. More or less area may be needed depending on specific conditions such as temperature, vibration and other unique end use requirements. Once the square area of engaged Dual Lock reclosable fastener is determined a Dual Lock reclosable fastener on one of the materials is typically designed to be slightly larger than required. This allows the full engaged area to be obtained, even if slight misalignment occurs during engagement. Refer to the specific product information page for expected performance under various dynamic and static loads under different environmental factors. This will aid in designing in the appropriate safety factors.

For a variety of reasons the calculated amount of Dual Lock reclosable fasteners required may not be possible. In this case, a redesign of the parts being joined needs to be considered. An example is holding a heavy panel in shear against a wall. This may require more Dual Lock reclosable fastener than desired or feasible. In this case a redesign incorporating a ledge to support some of the panel weight may be an acceptable solution. In this case the amount of shear load supported by the Dual Lock reclosable fasteners has decreased, as the weight has shifted to the ledge. It may be important to reevaluate the tensile strength requirements to hold the panel against the wall.

Shapes and Sizes:

Often edge or corner lifting of Dual Lock reclosable fasteners can lead to premature failure, as well as undesirable appearance. Rounding the corners, placing the Dual Lock reclosable fasteners in a slightly recessed area of the material it will be attached to or providing raised edges around the Dual Lock reclosable fastener can reduce the possibility of corner or edge lifting. This may also improve the overall appearance of the Dual Lock reclosable fastener on the finished product. 3M Preferred Converters can provide precut Dual Lock reclosable fasteners of shapes and sizes to reduce the potential for edge lifting while meeting your other design requirements. Mechanically securing the corners of the Dual Lock reclosable fastener can also reduce the possibility of edge lifting, but may reduce closure performance.

Design Considerations
(continued)

There are also wide selections of 3M™ Dual Lock™ Reclosable Fasteners piece parts consisting of snap-in, pop-in, slide-in pieces as well as small parts which can be fastened using mechanical fasteners. Refer to the Dual Lock Reclosable Fastener Piece Parts product selection guide for additional information on these options.

In addition, to the many roll good Dual Lock reclosable fastener products available, there is a rigid backed 3M™ Dual Lock™ Reclosable Fastener SJ3481 which can be thermoformed into angled bends and other shapes which maintain a given shape. This is useful for going around a corner. Dual Lock reclosable fasteners applied around corners will have reduced closure performance near an area of curvature as discussed below under the engagement and disengagement considerations section.

Thickness:

The distance between the two materials being joined is often called the stack-up or gap. It is important that the engaged thickness of the chosen Dual Lock reclosable fasteners meet the stack-up or gap requirements. The wide variety of backing options on Dual Lock reclosable fasteners permits a large range of engaged thicknesses. See *3M™ Dual Lock™ Piece Parts Reclosable Fasteners Technical Data and Design Guide* (70-0709-4005-4) for the various combinations available with our Dual Lock reclosable fastener products. The actual engaged thickness depends upon the chosen Dual Lock reclosable fasteners, the amount of load and the direction it is applied plus the chosen attachment option. Dual Lock reclosable fasteners engaged with Dual Lock reclosable fasteners has a much more predictable and small thickness variation than Dual Lock reclosable fasteners engaged with many loop materials.

With increased loading, Dual Lock reclosable fasteners engaged to Dual Lock reclosable fasteners will reach an initial minimum engaged thickness at the point when the mushroom heads on opposing fasteners just bottom out against the base film of the mating piece. For pressure sensitive adhesives, and some other attachment options, additional reduction may occur in the engaged thickness as the adhesive is further compressed under an increasing load. In most cases when the load is removed, the product will recover to its original thickness in a short time period.

When the two surfaces to which Dual Lock reclosable fasteners are bonded are separated the engaged thickness will increase to an initial maximum, just before the Dual Lock reclosable fasteners disengage. The engaged thickness will continue to increase until the force required to separate the Dual Lock reclosable fasteners exceeds the force to separate the joined materials and attachment method. For thick, conformable adhesives this could be a significant distance compared to thin or firm adhesives.

Dual Lock reclosable fasteners family of products engaged with loop materials, such as 3M™ Scotchmate™ Reclosable Fastener Loop products will have a much greater variation in engaged thickness depending upon the loading. The mushroom topped stems of Dual Lock reclosable fasteners, acting like a hook can engage with many loops. This could give a very large opening between two materials, even though the Dual Lock reclosable fasteners have some degree of engagement. Again with increased load, the gap between the joined materials will continue to be compressed as the Dual Lock reclosable fastener is further pressed against the lofty loop material. Applying a separation force will cause a large gap before disengagement occurs. This can lead to a sagging appearance in the finished product. There are special situations were some movement is required and this may be a desired closure option.

Engagement and Disengagement Considerations:

When joining two rigid materials with Dual Lock reclosable fasteners it is important the two substrates be as flat and parallel to each other as possible. If not, the two rigid materials it may be difficult to engage, or the stems may be damaged. This may compromise the closure strength and cycle life.

Design Considerations ***(continued)***

Engaging a 3M™ Dual Lock™ Reclosable Fastener type 250 to type 250 for widths less than 3/4" (19 mm) wide is not recommended as the potential for low disengagement forces may exist. If narrow widths are required it is suggested to use either wider Dual Lock reclosable fastener pieces, or use a Dual Lock reclosable fastener type 170 or type 250 engaged to type 400. Dual Lock reclosable fastener type 170 or type 400 engaged to type 400 are not recommended as the former is too weak and the later may be too strong potentially causing part damage or creating ergonomic issues.

As explained, more engaged stems will provide higher disengagement forces. With this gain in strength, comes an increase in the amount of force required to engage two Dual Lock reclosable fasteners. Because of the increased engagement force with higher stem densities, the potential may exist for damage to the materials being joined, especially if they are fragile components. Additionally the high engagement forces may require evaluation of any potential issues arising from manual engagement.

It is recommended that small pieces (less than 2" x 2") of Dual Lock reclosable fasteners be engaged to small pieces or strips of Dual Lock reclosable fasteners. Engaging strips (greater than 2" in length) of Dual Lock reclosable fasteners to strips of Dual Lock reclosable fasteners may create a situation where low disengagement forces may exist. This is caused by incompletely engaging all of the Dual Lock reclosable fasteners stems along the full strip. Dual Lock reclosable fasteners pieces and strips are easily and quickly engaged to pieces or strips of 3M™ Scotchmate™ Reclosable Fastener Loop.

Scotchmate reclosable fastener loop engaged to Dual Lock reclosable fastener may provide a high strength closure over Dual Lock reclosable fastener to Dual Lock reclosable fastener combinations.

To achieve maximum tensile or static disengagement forces or load supported, it is important that the two materials joined together are separated with the materials moving parallel to and either away from (tensile) or along (shear) each other. If the two materials are not parallel during usage, cleavage (rigid to rigid) or peel (flexible to flexible to rigid applications) opening may occur. These disengagement modes require less force than tensile or shear disengagement and premature failure may occur if not properly designed. As materials joined with Dual Lock reclosable fasteners are separated, there is a possibility that the mode of disengagement may change from a tensile disengagement with two rigid panels to cleavage disengagement. Cleavage separation may require less force and disengagement may occur sooner than expected. If the materials are not separated in a parallel fashion, then a peel or cleavage disengagement will occur, often with less force or load than in true parallel fashion. If one or both substrates are flexible, it can be difficult to keep the surfaces parallel during separation; therefore, the forces or load to separate are often less than with two rigid substrates. Dual Lock reclosable fasteners applied around corners will have reduced closure performance near an area of curvature. This is caused by the heads being slightly closer or further apart than on flat surfaces.

Finished product appearance – Product color:

In some applications parts or the entire Dual Lock reclosable fastener may show during use or at times when the product is disengaged for part repairs, maintenance or similar situations. Having a black Dual Lock reclosable fastener against a white surface may give an undesirable visual appearance. Standard Dual Lock reclosable fasteners are currently available in black or clear. Both of these products can be provided with clear, white or black adhesives giving much better control over the finished product appearance. 3M™ Dual Lock™ Low Profile Reclosable Fastener SJ4570 and SJ4580 are currently available only in clear, with clear adhesives. This combination provides for a very transparent product, allowing colors to show through the Dual Lock reclosable fastener more easily than even with our clear 3M™ Dual Lock™ Reclosable Fastener SJ3560 family of products.

Design Considerations ***(continued)***

Usage (performance) requirements:

The type of stress (peel, cleavage, tensile or shear) and load (static or dynamic) are critical factors to consider in designing the proper amount of 3M™ Dual Lock™ Reclosable Fasteners. After engagement, Dual Lock reclosable fasteners may slip or creep in the direction of the forces being applied, especially when subjected to temperatures or loads greater than indicated on the product information pages for the respective Dual Lock reclosable fastener combination. Dual Lock reclosable fasteners should not be subjected to temperatures above 220°F (105°C). Temperatures greater than 220°F (105°C), especially for long time periods or with high applied loads, the polypropylene may soften causing head and stem deformation with potentially irreversible performance loss.

Product movement or vibrations during use may affect long term performance. This may include an increase in disengagement forces for Dual Lock reclosable fasteners engaged to 3M™ Scotchmate™ Reclosable Fastener Loops. If a more consistent disengagement force is required during the life of the product, then Dual Lock reclosable fastener engaged to Dual Lock reclosable fastener configurations should be evaluated. Additionally, for applications with high compressional loading combined with dynamic shearing motion the complete loss of Dual Lock reclosable fasteners stems may occur. In this situation, a switch to a Dual Lock reclosable fastener engaged to Scotchmate reclosable fastener loop or a Scotchmate reclosable fastener hook and loop combination should be evaluated.

Two levels of forces are typically observed when opening a closure. There is usually a large initial force required to initiate closure opening, especially during peeling. Once the initial force has been exceeded, there is often a lower force required to continue the closure opening. Because of this, it is important to factor this into the design phase, so the force required to continue peeling is not achieved during undesirable times in the application. It is critical to ensure that closure openings occur when desired.

Supporting a heavy load may exceed the strength of the Dual Lock reclosable fasteners. In this case, a redesign of the application may be required as discussed above in the section Fastener characteristics and requirements, amounts to use.

Where to Use:

When two different stem types are used in joining materials together, it usually is not a concern as to which stem type goes to which surface. One need to consider in the design is the reducing the possibility of stem damage which are more easily damaged when not engaged. Care should be exercised in the design to minimize the opportunity for non-engaged stems to be exposed during manufacturing or use. In applications where one surface with the attached Dual Lock reclosable fastener may be exposed to bumping, knocking or rough handling, it is suggested that the higher stem density be applied to this surface, or temporarily protected until engaged with a mating Dual Lock reclosable fastener. This may reduce the change for stem damage. Temporary protection could be accomplished by engaged a piece to Dual Lock reclosable fastener Type 170 or Type 250 with no back coating, such as 3M™ Dual Lock™ Reclosable Fasteners SJ3442, SJ3742, SJ3780 or SJ3440 to the Dual Lock reclosable fastener attached to the material.

These stems may also easily engage with various loop materials, which may be undesirable in some situations. One example would be during cleaning, as the Dual Lock reclosable fastener may become entangled with fabric or loop material, making it difficult to separate. Damage to the loops could occur, or the stems could be damaged, causing visual or performance degradation. Designs should address the need to prevent undesired contact with loop material during normal usage.

Cycle life is the number of openings and closures the engaged Dual Lock reclosable fasteners experience before reducing the peel strength to 50% of the initial, first closure opening value. In many cases, dynamic cleavage, tensile or shear may be more critical to the end users final application. In that case, the stated cycle life may be more or less than the value based upon peel results and appropriate tests should be conducted to ensure an acceptable number of cycles for the desired application.

Design Considerations ***(continued)***

Exposure to environmental conditions:

To prevent premature adhesive failure, it is important that the attachment method be suitable for the environmental and expected use conditions. The times these 3M™ Dual Lock™ Reclosable Fasteners are expected to perform under various environmental conditions can affect longevity of the closure system. Prolonged periods of exposure to environmental factors such as temperature extremes or cycling, humidity and moisture or exposure to ultraviolet radiation may affect the closure strength and long term performance. Some of these Dual Lock reclosable fasteners have better long term performance to specific environmental exposures. For example, 3M™ Dual Lock™ Low Profile Reclosable Fastener SJ4570 is designed for indoor use with indirect or short duration exposure to ultraviolet radiation. If direct or long term UV exposure is required, then 3M™ Dual Lock™ Low Profile Reclosable Fastener SJ4580 or any of our standard thickness Dual Lock reclosable fastener products should be evaluated. Similarly 3M™ Dual Lock™ Reclosable Fastener SJ3560, and many of our Dual Lock reclosable fasteners products with acrylic based adhesives are designed to function better in outdoor environments than the 3M™ Dual Lock™ Reclosable Fastener SJ3540 family of rubber based products.

Material characteristics:

The surface energy of the material is a large factor in determining the best attachment system. Acrylic adhesives typically have much better adhesion to medium and high surface energy materials such as ABS, polycarbonate and most metals. 3M™ Dual Lock™ Reclosable Fastener SJ3245 and Dual Lock reclosable fastener SJ4570 products are designed for adhesion to low surface energy materials such as polyethylene and polypropylene. Alternatively, rubber based adhesives work well when bonded to low surface energy, as well as high surface energy materials. These rubber-based adhesives usually have lower temperature performance and reduced adhesive life in outdoor environments. If the material being bonded to is polypropylene, then the 3M™ Dual Lock™ Reclosable Fastener SJ3769 products can be evaluated for ultrasonically bonding.

To prevent premature adhesive failure, it is also important that the attachment method be suitable for the materials to which the Dual Lock reclosable fastener will be attached. Rubber-based adhesives for example are attacked by plasticizers found in many flexible vinyl and other plasticized materials. Typically, within a year, the rubber-based adhesives lose their strength, causing the Dual Lock reclosable fastener to prematurely remove from the material, often leaving a soft sticky residue on the material. Therefore, rubber-based adhesives should not be used on flexible vinyl and other plasticized materials. Many other attachment methods, including Dual Lock reclosable fasteners with 3M's acrylic adhesive should be evaluated for attaching the Dual Lock reclosable fastener to plasticized materials.

The porosity of the material to which Dual Lock reclosable fasteners will be adhered can greatly affect the ultimate bond strength achievable or material performance during disengagement of the Dual Lock reclosable fastener. Highly porous or fibrous materials may not have the internal strength required during disengagement and may tear or rip. In these situations, it may be required to evaluate different materials to apply a surface sealer or an alternative closure system requiring less force to open.

High surface roughness or texture of the material to which Dual Lock reclosable fasteners will be adhered can reduce the ultimate bond strength of a pressure sensitive adhesive attachment system. In these situations, it may be required to evaluate a design change to reduce the surface texture, removal of the surface roughness before application, use of a conformable pressure sensitive adhesive, liquid adhesives or mechanical attachment. Some of these alternative attachment options are discussed under various technical bulletins.

Design Considerations ***(continued)***

Installation and attachment needs:

Standard 3M™ Dual Lock™ Reclosable Fasteners has many backing options available making it easier to choose the attachment method giving you the highest strength bond between the material and Dual Lock reclosable fasteners. An example is Dual Lock reclosable fastener with a non-woven backing, such as 3M™ Dual Lock™ Reclosable Fastener SJ3223, that can be easily bonded to a fabric or porous material using a liquid adhesive. Alternatively, one of our individual Dual Lock reclosable fastener piece parts could be snapped into or mechanically attached to a thin rigid material with a pre-drilled hole of appropriate size and shape.

Dual Lock reclosable fasteners with our acrylic adhesives perform well in applications where the two bonded surfaces may differentially expand or contract, Dual Lock reclosable fasteners typically tolerate movement up to about three times the thickness of the acrylic adhesive. Because of these flexible adhesive bonds, design modifications or periodic use of traditional mechanical fasteners may be needed to achieve a more rigid, stiff assembly, if required.

Because Dual Lock reclosable fastener engaged to 3M™ Scotchmate™ Reclosable Fastener Loop provides increased closure strength extra care should be given to ensure the maximum bond strength is obtained to the substrates being joined. Failure to obtain bond strengths to the substrate that are sufficiently high may cause the Dual Lock reclosable fasteners to release from the substrate upon disengagement. Refer to the technical bulletin, *3M™ Dual Lock™ Reclosable Fasteners – Attachment using Pressure Sensitive Adhesives or Heat Bonding* (70-0709-4006-2) for suggestions on the proper methods for ensuring maximum strength to the substrate.

In some cases these Dual Lock reclosable fasteners may need additional support during dwell time required to build maximum bond strength, or under certain use conditions. Supplemental mechanical attachment could be considered.

As with all bond methods extremely low or high temperatures, vibration or impact, humidity, ultraviolet radiation may compromise the bond strength. If these conditions exist during use of the final product, the user is required to evaluate the proposed bonding method under expected use conditions.

Details on procedures for attaching Dual Lock reclosable fasteners using various methods suitable for the different backing types are summarized on separate technical bulletins.

Roll good backing type					
Backing Type	Pressure Sensitive Adhesives		Non-woven	None (Plainback)	Ultrasonic* (Semi-rigid)
	Acrylic adhesive	Rubber adhesive			
Attachment Method Technical Bulletin					
Pressure Sensitive Adhesive	✔	✔			
Heat Bonding		✔			
Curable Liquid Adhesives			✔		
Hot Melt			✔		
Sewing				✔	✔
Mechanical			✔	✔	✔
Ultrasonic*					✔

***To polypropylene type materials.

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Surface Preparation and 3M™ Dual Lock™ Reclosable Fastener Attachment

After the four critical design criteria

1. **The characteristics of the chosen 3M™ Dual Lock™ Reclosable Fasteners,**
2. **The material to which the Dual Lock reclosable fastener is applied,**
3. **Usage requirements including the environment in which it is expected to perform, and**
4. **Installation procedures and methods**

have been evaluated, proper surface preparation and Dual Lock reclosable fastener attachment methods need to be considered. Refer to specific technical bulletins for the Dual Lock reclosable fasteners that will be evaluated as to suitability for the final application.

Product Use

All statements, technical information and recommendations contained in this document are based upon tests or experience that 3M believes are reliable. However, many factors beyond 3M's control can affect the use and performance of a 3M product in a particular application, including the conditions under which the product is used and the time and environmental conditions in which the product is expected to perform. Since these factors are uniquely within the user's knowledge and control, it is essential that the user evaluate the 3M product to determine whether it is fit for a particular purpose and suitable for the user's method of application.

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