3M Renewable Energy Division

Window Film

Manual 2015

3M

3M™ Window Film

Table of Contents

3M™ Window Film

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3M™ Window Film
3M Window Film Manual

Why use the window film manual?

The purpose of this document is to be a comprehensive technical manual and technical resource for both internal 3M employees as well as 3M window film dealers and distributors. This document SHOULD NOT be made public in it's entirety, as consumers do not need the amount of information contained herein; however, individual pages of this document MAY be given to an end customer in support of a sale of 3M Window Film. This document contains detailed information on the entire US 3M Window Film Portfolio, and information contained within this document is based on relevant US industry standard test methods. Outside of the United States, naming conventions and product portfolios may differ.

Additional Resources

3M window film public US internet site- www.3m.com/windowfilm

- Dealer Advantage – This is an extranet site intended for use by internal 3M employees globally as well as US 3M Window Film Dealers. This site is password protected and you will need to register for access. This site houses latest news, technical information for all segments, upcoming events, sample US warranty documents, sales presentations, US promotions and programs, Sales Literature, Images, Ads & Logos, and Videos. You can access this site by going to www.3m.com/windowfilm and choosing Dealers, in the bottom right hand corner.
    - If you are new to the business, or have recently hired new employees, or simply need a refresher, the following documents/videos would be advisable for you to read/watch:
    - Under Technical –Flat Glass- Manuals and Bulletins
        - 3M Bulletin – Understanding Solar Performance
    - Under Technical - Flat Glass
        - Sun Control Training: All Videos
        - Safety & Security Training – All Videos and Bulletins
- Once you have accessed Dealer Advantage, you will have access to all of the most up-to-date related links Product Lines

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3M™ Window Film
Product Lines
3M™ Sun Control Window Films

Prestige Series
With 3M™ Window Film Prestige Series, you can enjoy the benefits of a world-class window film while leaving the beauty of your windows virtually unchanged. Because 3M™ Window Film Prestige Series use no metals, they are not susceptible to corrosion in coastal environments and do not interfere with mobile phone reception. Other window films that reject heat tend to have high reflectivity, but not Prestige Series Window Films. These films offer reflectivity that is actually lower than glass. A final key technical feature of the Prestige line of products is that they were designed to perform best when the sun is high, at the hottest parts of the day, so when the sun is working hardest our films are performing their best.

Exterior Prestige Series
With 3M™ Window Film Prestige Exterior Series, you have the only non-metallized spectrally selective IR reflecting window exterior window film. The Prestige Exterior Series window films have a UV durable hardcoat, enabling the product to stand up to the harsh outdoor environment. This film is also the only exterior film that you do not have to edge seal for all vertical glass. With the Prestige Exterior Series, you get all of the same benefits as the interior version plus, signicantly more energy rejection especially on double pane glass, you can have easier access to skylight glass, and you can install film on glass that you may not have been able to install interior film on. The Prestige Exterior Series window film is truly unique in the industry.

Ceramic Series
With 3M™ Ceramic Series Window Films, you have a nice median between the Prestige Series and Night Vision Series window films. These films utilize a layer of ceramic material to reflect solar energy. The Ceramic Series product line will not reflect quite as much energy as the Prestige Series and they will also be more reflective, however they will offer a higher visible light transmission than the Night Vision Series. These products contain no metals, so there will be no signal interference.

Night Vision Series
With 3M™ Night Vision Window Films, you get the exceptional performance of a reflective film while still being able to look through the film at night. Traditional metalized films reflect equally both inside and outside, becoming mirror-like at night. The Night Vision line reflects more to the outside, where you need it, and less to the inside. Our high technology, carbon impregnated polyester layer provides outstanding heat rejection performance as well and gives the film a warm bronze appearance.

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3M™ Window Film
Product Lines

3M™ Sun Control Window Films Continued

Traditional Series
These products normally have a thin adhesive for optimum clarity, and a micro layer of metal evenly coated on the film to reflect the infrared solar radiation. Their main task is to help reduce the amount of heat coming into a building through the windows. They help reduce glare, UV damage, can improve aesthetics of the building, and offer different levels of privacy depending on the product chosen.

Traditional Series Exterior
The Traditional Exterior Series sun control films have all of the same benefits as the interior series, yet they have the added benefit of a UV resistant hardcoat so the films can be installed on the exterior. Exterior films allow you to more easily install film on skylights, and some hard to reach windows from the interior, reduce thermal stress, and reject more energy. It is important to note that the Traditional Series Exterior films are made with metal, and therefore require an edge seal.

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3M™ Window Film
Product Lines

3M™ Safety and Security Window Films

3M™ Scotchshield™ Ultra Series

A patented micro-layer film with TEAR-RESISTANT and BALANCED FILM PROPERTIES, and an excellent strength adhesive system. These products are designed to hold broken glass onto the film thus helping to reduce the possibility of injury or damage caused by flying glass shards. The unique tear-resistant properties of our micro-layered film provide an enhanced measure of protection against hazards caused by industrial explosions, terrorist bombings, earthquakes, spontaneous glass breakage, Smash & Grab or other Break & Entry events. Versions are also available with sun control features.

Safety Series

Standard safety and security films utilizing conventional film grade polyester. These products are designed to hold broken glass onto the film thus helping to reduce the possibility of injury or damage caused by flying glass shards. Useful for many of the same applications listed above, but often will require a thicker film to be as effective.

Safety Exterior Series

Like the Safety Series but with an exterior durable hardcoat. These films are actually dual purpose interior / exterior safety films.

3M™ Privacy Series Films

These 2 mil polyester films are designed for interior use where enhanced privacy is desired. Product choices are 3M™ White Matte, 3M™ Mirror, and 3M™ Blackout. They are not recommended for application on exterior windows.

Anti Graffiti Series

Graffiti artists are changing their techniques to create their “works of art.” In place of using only spray paints and markers to deface glass and other smooth surfaces, vandals are also using glass-etching solutions and tungsten carbide styluses for scratching and defacing your property. 3M Anti Graffiti films will resist these and other types of graffiti while helping to safeguard your property. Once applied the film will also help provide protection from broken glass by holding the glass together.

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3M™ Window Film
Product Lines

3M™ Safety and Security Window Films (Continued)

3M™ Impact Protection Attachment Systems

3M™ Impact Protection Profile (IPP)

A “flexible-mechanical” attachment system designed to anchor safety and security window film to the window. The attachment system helps secure filmed broken glass in the window frame, thus providing an increased level of safety and security for a broad range of applications, including basic glass fragment retention, spontaneous glass breakage, seismic preparedness, bomb blast mitigation, and deterring Smash and Grab or Break and Entry events. The attachment system has a consistent appearance, is odorless, and exhibits a fast cure time.

3M™ Impact Protection Adhesive (IPA)

A “wet glaze” style film attachment designed to anchor the film to the frame. The attachment system helps secure filmed broken glass in the window frame, thus providing an increased level of safety and security for a broad range of applications, including basic glass fragment retention, spontaneous glass breakage, seismic preparedness, bomb blast mitigation, and deterring Smash and Grab or Break and Entry events. The wet glaze has low VOC content, low odor, and fast cure time.

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3M™ Window Film
Product Lines
3M™ Automotive Window Films

Crystalline Series
Superior in quality, the new 3M™ Crystalline Automotive Window Films are innovative, high-technology films that represent a clear breakthrough in automotive window films. Developed in our industry-leading laboratories, 3M Crystalline Automotive Window Films are produced using multilayer nanotechnology, the same advanced technology used to improve the brightness in flat panel LCD televisions. 3M™ Crystalline Automotive Window Films, has set a superior standard for enhanced protection, comfort and style in automotive window films.

Breakthrough multilayer nanotechnology • Metal-free design with zero electronic interference*
Much less reflectivity than traditional window films • Advanced heat rejection capability
Full 99.9% UV protection (SPF 1700+)
National limited lifetime manufacturer's warranty

*Will not interfere with cell phones, GPS systems or satellite radio **IR for wavelength range of 900-1000nm

Color Stable Series
These products have an exciting new technology that protects the film from changing color. These products also have an adhesive system designed to hold to curved automobile glass. They also have features that allow the installers to smooth the film to the glass with fewer wrinkles, bubbles or other problems, thus providing the car owner with a high quality application. All products feature a distinctive color that complements the automobile color and provides a sleek appearance.

Black Chrome Series
3M™ Black Chrome Automotive Window Films are a premium line of metallic window films that not only enhance your vehicle's appearance, but offer excellent heat rejection, glare control, privacy, and protection from the damaging UV effects of the sun. 3M™ Black Chrome Automotive Window Films come with a limited lifetime warranty against peeling, bubbling, blistering, fading or discoloration.

FX Series
3M now offers three automotive window film product lines: FX Standard (FX-ST) delivers good looks and good performance. FX-ST utilizes a dyed film technology and comes with a 3 year limited warranty. FX High Performance (FX-HP) combines a dyed film with a metalized film to provide additional heat rejection and improved comfort. FX Premium (FX-PM) delivers good looks and great performance. FX-PM offers an economical alternative without sacrificing quality and comes with a limited-lifetime warranty. All product lines provide 99% UV protection, scratch resistant coating, and several different shading levels in an attractive charcoal hue.

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3M™ Window Film
Identification System

Sun Control Films

For all sun control films, the numerical value in the product name refers to the approximate visible light transmission of the product as measured on ¼" clear glass.

Example: Prestige 70 – VLT on ¼" clear glass = 69%

Prestige and Night Vision Series Sun Control Films

Each Prestige Series and Night Vision sun control film begins with the name of the series. The benefits of the series are described in detail in the previous pages. Prestige is often abbreviated as "PR" and Night Vision as "NV".

Examples: Night Vision 15, Prestige 40

Ceramic Series Sun Control Films

Ceramic series sun controls films begin with the name "Ceramic", and in this case the films utilize a ceramic layer to reflect solar energy. Unlike the traditional series, ceramic actually refers to the material used to reflect the solar energy.

Example: Ceramic 30

Traditional Series Sun Control Films

Each traditional series sun control film is labeled as a perceived color or appearance. The name for the traditional series films DOES NOT REFER TO THE TYPE OF METAL IN THE FILM. The name solely refers to the perceived appearance of the film.

Examples: Neutral 35 – Neutral in color; Silver 35 – Silver in color

Exterior Sun Control Films

Each exterior applied sun control film will have "exterior" in the name of the product. The exterior products may be abbreviated to include an "X" in the name, such as PRX.

Examples: Exterior Prestige 40; Exterior Silver 15

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3M™ Window Film
Identification System -- Safety and Security Window Films

All 3M Safety and Security Window Films have the letter "S" (meaning "safety/security") as part of the product name designation. The guidelines below are intended to help better understand the naming rationale of products in this category.

3M™ Scotchshield™ Ultra Series

"Ultra" refers to 3M's patented tear'resistant film that uses micro-layered film technology. All products that incorporate the tear resistant film will be prefaced by the word, "Ultra". The 3M Scotchshield trademark is associated with all Ultra, tear-resistant safety films.

Ultra S600: Optically clear tear resistant film, 6-mils thick.
Ultra S800: Optically clear tear resistant film, 8-mils thick.

Ultra films with Sun Control: These films combine the micro-layered tear-resistant film technology of "Ultra" with an additional layer of 3M™ Sun Contol film laminated to it (refer to the naming convention system of Sun Control films on the previous page). Therefore, these films incorporate both the word "Ultra" and the type of sun control film, with the "S" designation again referring to "safety/security". Because these are combination safety films with sun control, the numerical suffix refers to the % visible light transmission - not film thickness. These films are sometimes abbreviated without the word "Ultra" as shown in the following examples:

Examples:	Abbreviated:
Ultra Prestige S70	PR-S70
Ultra Prestige S50	PR-S50
Ultra Night Vision S25	NV-S25

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3M™ Window Film
Identification System -- Safety and Security Window Films

Safety Series
The word,"Safety", in this product line refes to safety and security films that utilize *conventional* polyester (ie, NOT tear-resisant Ultra film). These products are differentiated by their nominal film thickness, which is identified by the *non-zero numerical digits* following the "S".

Examples:
Safety S40 (4 mils thick)
Safety S70 (7 mils)
Safety S80 (8 mils)
Safety S140 (14 mils)

Exterior Safety film is named in similar fashion, but with the letter "X" suffix in abbreviated form.

Examples:	Abbreviated:
Safety S20 Exterior, (2 mils thick)	S20X
Safety S40 Exterior (4 mils),	S40X
Safety S70 Exterior (7 mils)	S70X

For Safety Series with Sun Control, the nominal film thickness is not indicated; rather, the type of 3M™ Sun Control Film follows the word "Safety", with the letter "S" preceding the VLT value.

Examples:
Safety Neutral S35
Safety Silver S20

Attachment Systems
3M™ Impact Protection Adhesive = "IPA"
3M™ Impact Protection Profile = "IPP". BP = Black Profile; WP = White Profile

Anti-Graffiti Films
Numerical designation refers to film thickness.

Examples: Anti-Graffiti 4 (4 mils thick), Anti-Graffiti 6 (6 mils)
Abbreviated: AG4, AG6

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3M™ Window Film
Identification System -- Safety and Security Window Films

FOR REFERENCE ONLY – HISTORICAL NAMING CONVENTION

Safety Series

When safety and and security films were first introduced by 3M, these films were often referred to as “shatter films”, or glass shatter resistant films. This class of products was identified in the first to alpha characters in the product code: “SH” – referring to “shatter films”. The following describes the rest of the historical naming convention:

“SH” – refers to film type; i.e, glass **sh**atter resistant film
“#” – number that indicates the film thickness, in mils
“CL” – refers to appearance; i.e, **cl**ear film
“AR” – refers to film wth an **a**brasion **r**esistant coating
“L” – refers to film with a removable **l**iner

Examples: SH7CLARL (7 mil thick film, clear, abrasion resistanct coating, with liner)
SH4CLARXL (4 mil thick exterior film, clear, abrasion resistanct coating, with liner)
SH14CLARL (14 mil thick film, clear, abrasion resistanct coating, with liner)

Ultra Series

Ultra films had a different product code naming system to distinguish them from the conventional “shatter films”.

1st letter = “S”, for safety/security
Next 2 digits (for Ultra films with sun control only) = % visible light transionmission
Next two letters: referring to color; i.e, clear film (CL), Neutral (NE), Silver (SI), Night Vision (NV)
“AR” – refers to film wth an **a**brasion **r**esistant coating
“L” – refers to film with a removable **l**iner
Last three digits – identify the thickness of the micolayered tear-resistant film layer (i.e.; ‘150’ = 2-mil microlayered film ‘400’ = 4-mil microlayered film)

Examples:
SCLARL150 (2 mil tear resistant safety film, clear, with liner, abrasion resistant; “Ultra S150”)
SCLARL400 (4 mil tear resistant safety film, clear, with liner, abrasion resistant; “Ultra S400”)
S35NEAR400 (safety film incorporating Neutral 35 and 4-mil microlayered films)
S25NVAR400 (safety film incorporating Night Vision 25 and 4-mil microlayered films)

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3M™ Window Film
Safety and Security Segments

Blast Mitigation

It may be surprising to learn that blast hazard mitigation is actually one the biggest reasons why Safety and Security films are used today. But during a large explosive event, flying glass shards from windows are the primary cause of injuries and fatalities. Glass is the weakest component of the building envelope – and the pressure wave generated from the blast shatters the glass, turning windows into deadly glass shards.

Many types of buildings may be at a higher risk of explosive events. All federal and local government facilities are generally considered higher risk, including court houses, airports, administrative centers and of course, military buildings. Industrial facilities with susceptibility to accidental chemical explosions are also at risk. Financial districts or other business with sensitive information, such as large banks are other facilities at risk. Densely populated centers or tourist attractions, such as stadiums and arenas, or even any large corporations with international presence may be targets for terrorist activity. Cities that host large public events, such as the Olympic Games, World Cup, and political conventions may also be at increased risk of being targeted by terrorists.

So how do safety and security films provide protection against something as powerful as a bomb? The key is that the film helps provide a protective membrane on the interior surface of the glass, and the blast resistance needs to hold up for only a fraction of a second. It is during this fraction of a second when the blast pressure wave moves across the window and the glass instantly shatters. The film does an excellent job of containing the shattered fragments, not only through the film's adhesive bond strength to the glass, but also by resisting tearing. Blast protection generally increases with film thickness. Standard polyester-based window films less than 7 mils thick typically tear under the most commonly tested blast loads, thus creating an opening in the window for hazardous glass shards to penetrate inside to the inhabited space. So unless the film has additional tear-resistant properties (like some 3M films), films less than 7 mils thick are not used in the blast hazard mitigation segment.

GSA Test Specification

While there are several industry test standards for blast hazard mitigation, one of the most common for window films is the GSA test specification. It is used to specify window upgrades on federal government administrative buildings. The GSA test standard, like other standards that rate products for blast mitigation, rates performance based on the level of glass shard penetration into the test structure.

The most frequently specified minimum level of performance is called GSA Level "3B". For 3B, glass shards from the blast do not penetrate any further than 10 feet from the original window position. Examples of higher levels of performance are GSA Level"3A", (where the glass fragments travel no further than 1 meter), and GSA Level 2, where all the glass is essentially contained in the window.

Supporting documentation for Blast Mitigation Projects

- Use the Blast Data Selector Tool on the Dealer Advantage Website
- Use relevant 3rd Party Test reports on the Dealer Advantage Website

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Safety and Security Segments

Safety Glazing

What is Safety Glazing? Generally speaking, safety glazing is any glass or plastic glazed product that is expected to break "safely" upon impact. Consider typical annealed float glass, which is commonly used on the windows of your home. When annealed glass breaks, it fragments into large, jagged shards that are capable of causing serious human injury. Annealed glass is not safety glass.

So where is Safety Glazing used? In the United States and many other regions of the world, building code requires that certain areas which use architectural glazing mitigate risk of human injury by using safety glazing. These high risk areas are those which may be more vulnerable to glass breakage due to accidental human impact. Examples include, glass doors, patio doors, shower doors and enclosures, balcony glass, elevator glass, and any glazing that is within 18 inches of floor level.

Tempered glass, however, breaks into relatively small pieces that pose a much lower risk to bodily injury. Additionally, tempered glass is more resistant to breaking. Tempered Glass is generally considered safety glazing.

Impact Tests for Safety Glazing

Impact resistance is tested by mounting a glass specimen, approximately 3 feet wide by 6 feet tall, into a test fixture. The test fixture has a pendulum containing a 100-lb bag that acts as the impactor. The impactor is dropped from a specified height to generate a certain level of impact force. Two primary heights (and corresponding forces) are used: an 18" drop height, which corresponds to 150 ft-lbs of force; and a 4-foot drop height, corresponding to 400 foot-pounds of force. Force, in foot-pounds is simply calculated by multiplying the weight of the impactor (in pounds) times the drop height (in feet).

ANSI Z97.1 and 16 CFR 1201 both require that multiple specimens are tested, and that an equal number of impacts are conducted on the filmed side of the glass as well as the glass side. Film attachment systems are NOT used; although there is a specified clamping pressure intended to keep the test specimen mounted in the frame, the test specimen is allowed to dislodge from the test fixture during impact.

Code Compliance

Safety Glazing applications almost always involve a code official's approval. Building Code in the US references the two industry standards just mentioned – ANSI Z97.1 and 16 CFR 1201. 3M has tested its safety and security window films to both standards. To determine which product is most suitable, refer to the 3M specification documents for that product, or go to the 3M Dealer Advantage site to view the 3rd party test reports. When submitting documents to a local code official, forward the relevant 3rd party test report to demonstrate compliance.

Supporting documentation for Safety Glazing

- 3rd Party test reports on the Dealer Advantage Website
- Safety Glazing decals available from Staples website

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3M™ Window Film
Safety and Security Segments

Deterring Break and Entry

First and foremost, when discussing the benefits of safety and security films for Break and Entry protection, it is important that you manage the customer's expectations regarding the performance of the film. Security Films do not offer any guarantee of protection, they offer an added measure of safety. By helping to contain the broken glass in the window frame, they can help provide precious response time in the event that an intruder attempted to enter your building or home, or provide additional asset protection from smash and grab burglaries. Security films can be a convenient upgrade to unprotected glass that helps to provide an additional layer of safety and security.

Attachment Systems

Attachment systems are highly recommended for all Break and Entry applications. First, attachment systems help keep the broken filmed glass upright in the window so that the intruder must pass through hazardous glass shards in the middle of the window instead of kicking out the glass at the frame edge. Secondly, glass that is in or near doors – a frequent access point for intruders – is usually tempered glass. Tempered glass tends to shatter into tiny pieces. Because of this break pattern of the glass, there is very little structural support provided by the glass itself near the frame edges of the window. Without an attachment system, filmed tempered glass could be easily penetrated with little force by simply kicking the window out of its frame. Lastly, Break and Entry events usually involve repeated, concentrated assault on the window. Without an attachment system, the weakest point of the window is near the frame edges. Anchoring the film forces the intruder to create and expand an opening in the film that is large enough to enable body passage.

Not all window and door frames can easily accommodate conventional methods of film anchorage. Many commercial doors, for example, do not have an outer frame surface area large enough to properly apply 3M IPP or 3M IPA. In these instances, it is recommended to remove the frame stops to expose the entire sheet of glass, film the glass, then apply IPA sealant to bond the film to the structural part of the door – and finally reattaching the frame stops.

Security Film Features

The most important film property for deterring break and entry is film thickness. While a film's tear resistance can be advantageous in inhibiting the expansion of an opening large enough to enable body passage, the puncture strength of a film is directly related to its film thickness. Thicker films are more difficult to penetrate. 3M recommends the minimum film thickness for a conventional polyester film is 8 mils; or 6 mils for a micro-layered tear-resistant film. While thicker is usually better, this comes at increased cost to the customer and installation challenges for the window film installer.

Lastly, optical properties of the film present different challenges to the intruder. An intruder may not notice when a clear film has been applied, while a dark tinted film can help conceal what's inside.

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1-866-499-8857
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3M™ Window Film
Safety and Security Segments

Deterring Break and Entry (cont'd)

The question is often asked, "What level of performance does the security film provide?" This is an impossible question to answer, in large part due to the numerous ways a window can be attacked. The security glazing industry has long struggled with developing meaningful test methods that translate well expected performance and resistance to forced entry. Furthermore, security glazing is not a feature that is addressed in commercial building code. For most film projects, the end-customer chooses security film based on the reduced cost compared to installing security glass, and properly established performance expectations based on available information.

Some insurance companies may offer a policy premium or deductable discount based on a standard test method, like UL 972. UL 972 involves dropping a steel ball on the glass – either once at a high drop height; or 5 times at a lower drop height. The ball must not completely penetrate the glass.

In the majority of cases, the most effective tools are to show videos of testing or actual break-in attempts, conduct demonstrations, or to forward 3rd party testing related to Break and Entry. These methods can help inform the customer and set expectations for what level of deterrent the film may be able to provide.

Supporting documentation for Deterring Break and Entry

- 3rd Party test reports on the Dealer Advantage Website
- Videos on 3M WindowFilmUSA YouTube Channel

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3M™ Window Film
Safety and Security Segments

Spontaneous Glass Breakage

Spontaneous Glass Breakage, or SGB, mostly applies to tempered glass. Tempered glass is used in Safety Glazing, or any glass that is required to be "break safe" according to building code. Tempered glass is very impact resistant because the glass is heated and then rapidly quenched while in a stressed state. When tempered glass breaks, it tends to uniformly shatter into small pieces that are considered relatively harmless. However, because of the residual stress in tempered glass, if it contains small contaminants– known as nickel sulfide inclusions – they can expand at a faster rate than the glass, causing the glass to spontaneously explode and shatter without any warning.

Many buildings use tempered glass in areas where the glass is elevated, such as glass balconies, glass guardrails and hand railings, along stairwells, and on curtain walls. The potential for spontaneous glass breakage in these elevated areas can present a serious risk to the people below. Safety Films provide an easy solution for helping to protect those below from the hazards of falling glass.

An important point to remember about using films for Spontaneous Glass Breakage is that this type of event is a NON-IMPACT situation. So unlike most other secrurity film applications, glass breakage is not caused by some external force directly impacting the glass. What this means is that a very thick safety and security film is not necessarily required in order to contain glass fragments. In most cases, all that is needed is substantial film adhesion to the glass for effective glass fragment retention.

Other Considerations

Another point to consider is that many SGB situations involve unique architectural designs where the glass itself is minimally supported. This is important because it has implications on how the filmed glass is anchored to the supporting structure. Anchoring the filmed glass may be critical when trying to secure elevated glass. Having a large pane of filmed glass falling down may be more hazardous than small fragments falling down. When possible, use a film attachment system to help secure the glass. Never assume that a simple daylight installation of film will secure tempered glass.

If the glass has exterior exposure, you may need to consider an Exterior Durable Safety Film, and perhaps even wind load requirements.

Each project must consider how long glass containment is needed. For example, is 8 hours sufficient, or would 3 days make more sense? When possible, it is recommended that an on-site demonstration be conducted to evaluate the film's efficacy for glass fragment retention.

Supporting Documention

- Case Studies available on Dealer Advantage website

3M™ Window Film
Safety and Security Segments

Seismic / Earthquake Preparedness

The benefits of film for seismic applications are similar to those for Spontaneous Glass Breakage. The main concern from a safety standpoint is to help prevent broken glass from falling down on pedestrians or building occupants who are below or near the glass. A secondary benefit of filming the glass for seismic applications is helping reduce the disruption of operations that occurred because of the earthquake. While Spontaneous Glass Breakage mostly applies to tempered glass, Seismic Applications apply to all types of glass because the movement of the building may break the glass.

Most local building codes in earthquake prone regions have regulations that pertain to glazing performance. In the US, however, few codes actually reference an industry test standard. Instead, they may specify a certain type of product. For example, the American Society of Civil Engineers (ASCE 31-03: Seismic Evaluation of Existing Buildings) states that "all exterior glazing shall be laminated glass or other glazing system that will remain in the frame when cracked". If the glass in a building is not laminated, safety films can provide an alternative upgrade solution because they can help keep broken glass in the window frame.

Japan has a standard, JIS A5759, that addresses safety film performance for seismic application. Performance is based on the percentage of glass that remains adhered to the film after the window is subjected to a simulated earthquake movment.

Film attachment systems are important in seismic applications also. While attaching along all 4 sides of the window is most secure, it may be sufficient to apply only along two sides (vertical) or along the upper frame member only.

Supporting Documention

- Contact 3M Window Films Technical Service

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3M™ Window Film
Safety and Security Segments

Windstorm Debris Protection

IMPORTANT NOTICE:
These products are <u>not approved</u> in the State of Florida for use as hurricane, windstorm, or impact protection from wind-borne debris from a hurricane or windstorm. In compliance with Florida Statute 553.842, these products may not be advertised, sold, offered, provided, distributed, or marketed in the State of Florida as hurricane, windstorm, or impact protection from wind-borne debris from a hurricane or windstorm.

Safety and Security Films can help provide building envelope protection during severe wind storms. Other terms for this include Wind Borne Debris Protection or Hurricane Protection. It is important to note that the term “protection” does not imply personal protection from glass-related injury that can be caused by such devastating storms – the primary purpose of safety and security films for this application to limit damage of property that can be caused when windows break due to the storm. Never promote safety and security films for personal protection during storm events. Residents should always seek shelter as advised.

Severe windstorms can impart significant property damage once the building enveloped is breached, and glass in windows is one of the weakest points in the building envelope. The damage is not isolated to wind or water damage to areas near a window; sustained high wind speeds can internally pressurize the building and cause extensive damage to the rest of the structure.

Not only do films attempt to limit the direct damage, but also limit the extent of lost business operations.
The safety and security film system must protect against two primary threats: 1) impact from wind borne debris, which can vary in size and impact speed; and 2) the extreme, sustained high speeds. Film attachment systems must be used for most effectiveness in windstorm protection. This is because the wind speeds may be so strong that the filmed glass would otherwise simply get blown in if not anchored to the window frame. The attachment system itself does little to mitigate direct impact from wind borne debris – this is determined primarily by the strength of the film. However, once the glass is broken by impact from wind borne debris, the strength of the attachment system is put to the test as it helps keep the filmed, broken glass upright in the window during long, sustained high wind speeds.

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3M™ Window Film
Safety and Security Segments

Windstorm Debris Protection (cont'd)

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Windstorm Resistance Test Standards
In the US, the prevailing industry standards that are referenced in building code and other specifying authorities are ASTM E1886 and E1996. In these standards, a set of windows are first subject to an airborne missile impact, which simulates impact for wind borne debris. After impact, the windows are then subjected to several hours of pressure cycling, which simulates the types of high wind loads a window may experience.

ASTMs E1866 and E1996 provide guidance as to how to test windows for a building located in a certain wind zone. For buildings that require what ASTM calls "Enhanced Protection", such as hospitals, police stations, emergency shelters, windows must be tested to a higher level of impact. For buildings deemed as requiring only "Basic Protection", such as most commercial buildings, a lower level of impact may be required. Determining the type of missile impact also depends on the Wind Zone in which the building is located, and whether the windows are above or below 30 feet grade. Most safety and security window films, applied in a retrofit fashion on existing buildings, can only meet Missile Level "C" or lower, thus limiting their scope of use to buildings requiring Basic Protection or less, located in Wind Zones 1 and 2.

Relevant products from 3M for Windstorm Debris Protection include the 3M Scotchshield Ultra Series, including those with sun control, 3M Safety Series with Sun Control, and 3M Impact Protection Attachment Systems.

Supporting Documention

- 3rd Party Test Reports on the Dealer Advantage website

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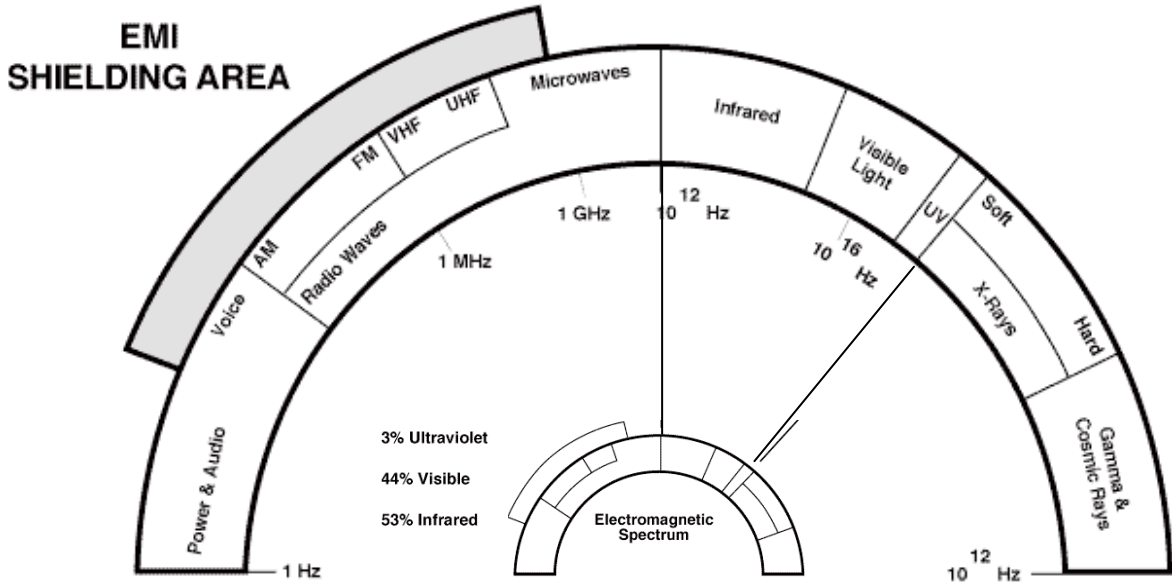
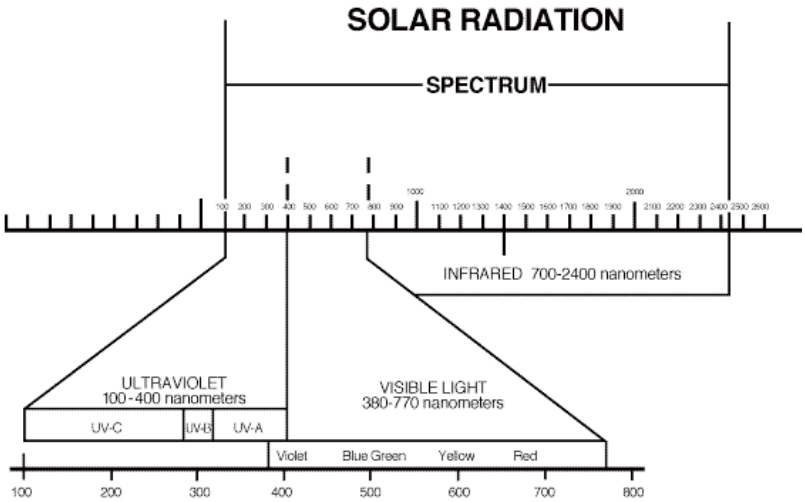
3M™ Window Film

General Information

ELECTROMAGNETIC SPECTRUM



SOLAR SPECTRUM



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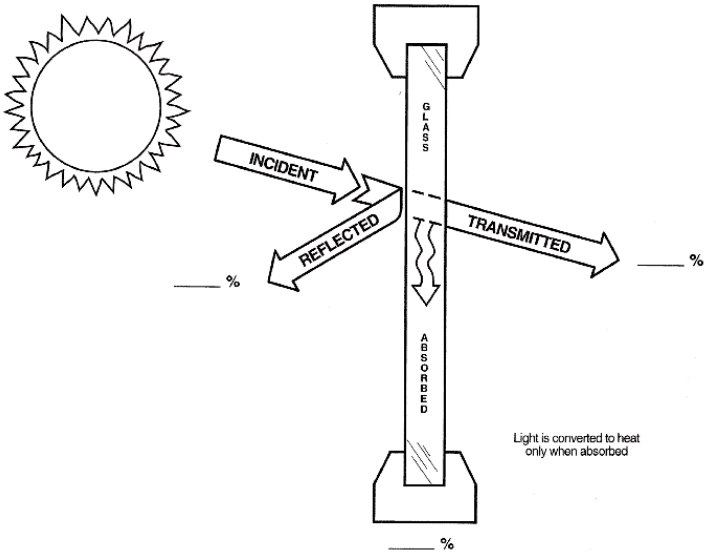
3M™ Window Film
General Information

WAVELENGTH

One Nanometer = .000000001 meters

TOTAL SOLAR ENERGY



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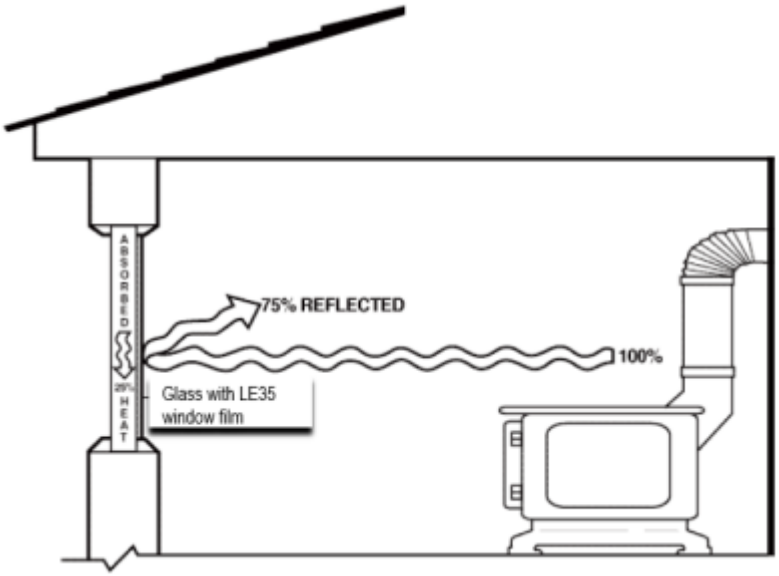
3M™ Window Film
General Information

EMISSIVITY

The ability of a surface to absorb heat and to reflect it



Emissivity of Some Materials

Gold, Polished	0.02
Silver, Polished	0.02
Aluminum, Polished	0.05
3M™ Sun Control Window Film Low E 35 (LE35) Film	0.51
3M™ Sun Control Window Film Silver P18ARL (P-18ARL) Film	0.66
Glass	0.84
Paper	0.89
Wood	0.91
White Enamel	0.91
Flat Black Lacquer	0.96

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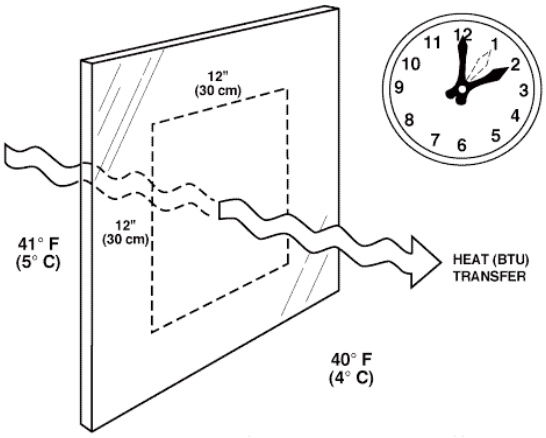
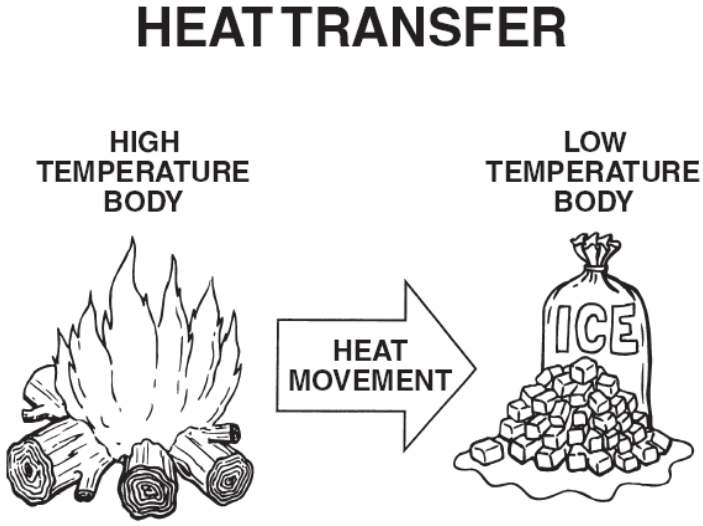
3M™ Window Film
General Information

“U” VALUE,“K” VALUE, “R”Value

The amount of heat passing through 1 sq. ft. (.092 sq meters) of glass in 1 hour for every 1° F (0.47° C) temperature difference
The “R” Value is the reciprocal of the U value (U=1/R)



HeatTransfer



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3M™ Window Film
General Information

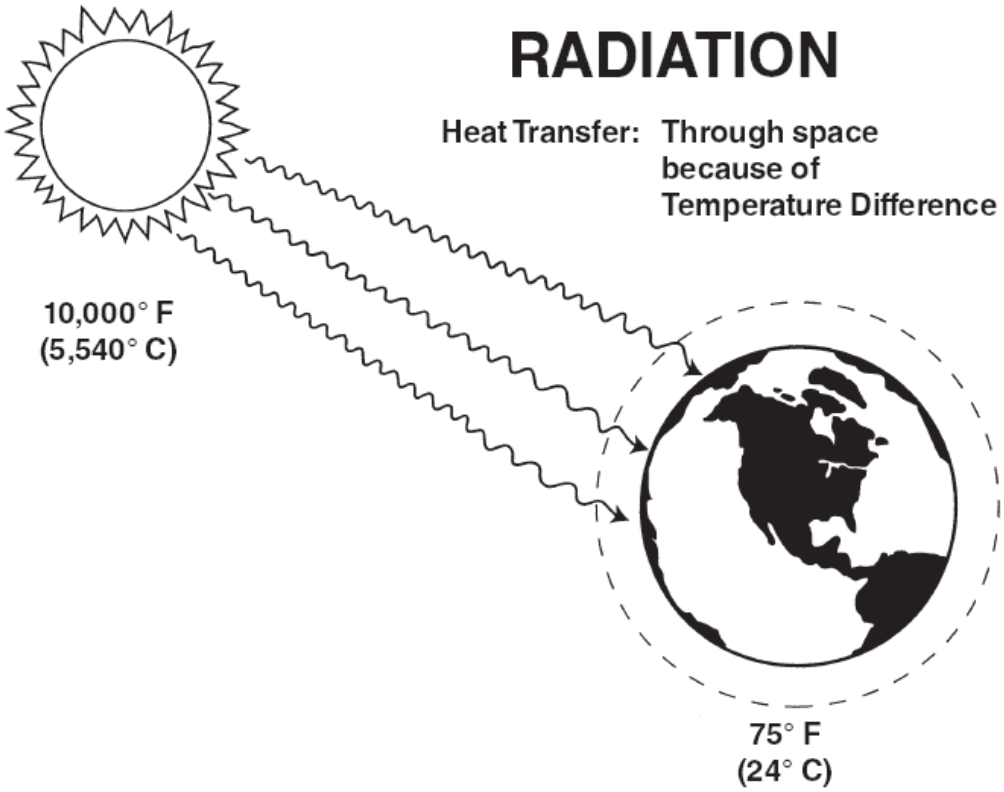
Methods of Heat Transfer

1. Radiation
2. Conduction
3. Convection

BTU (British Thermal Unit) : The amount of heat required to raise the temperature of one pound of water one degree Fahrenheit.

1 BTU = 252 Calories (CAL) = 1054 Joules (J)
1 KW = 3412 BTU
One Ton of Air Conditioning = 12,000 BTU/HOUR (3.52 kWh)

Radiation



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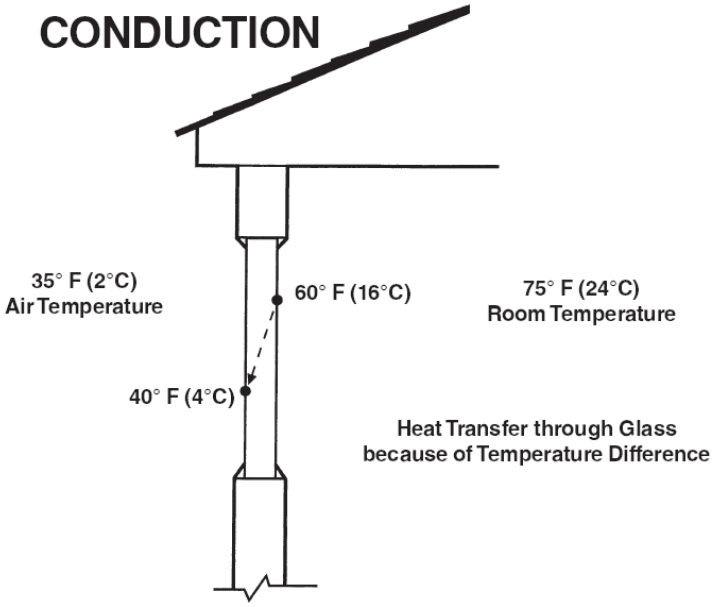
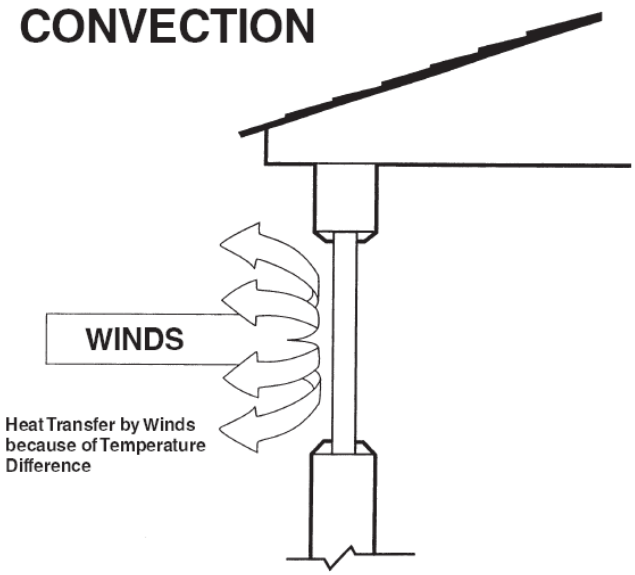
Conduction



Convection



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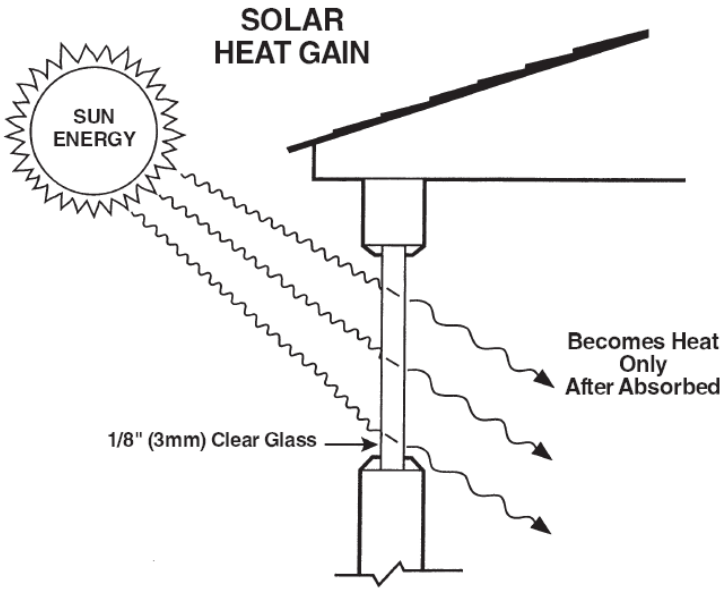
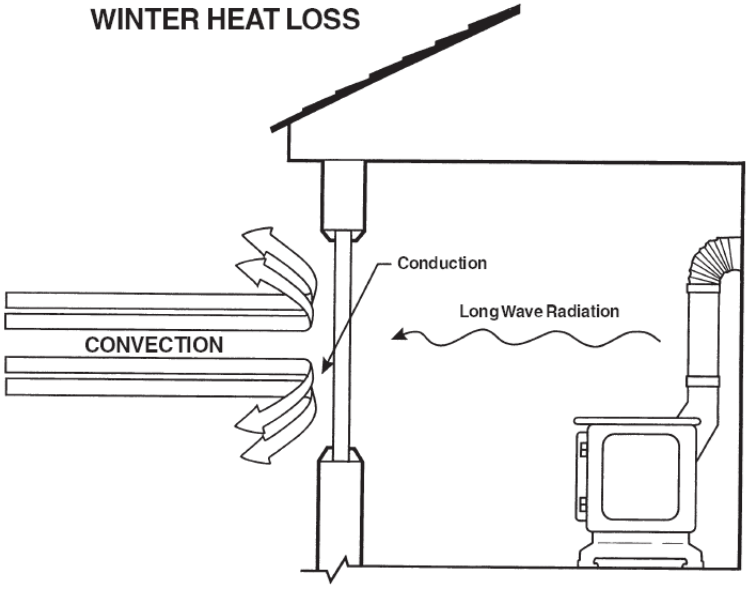
Solar Heat Gain



Winter Heat Loss



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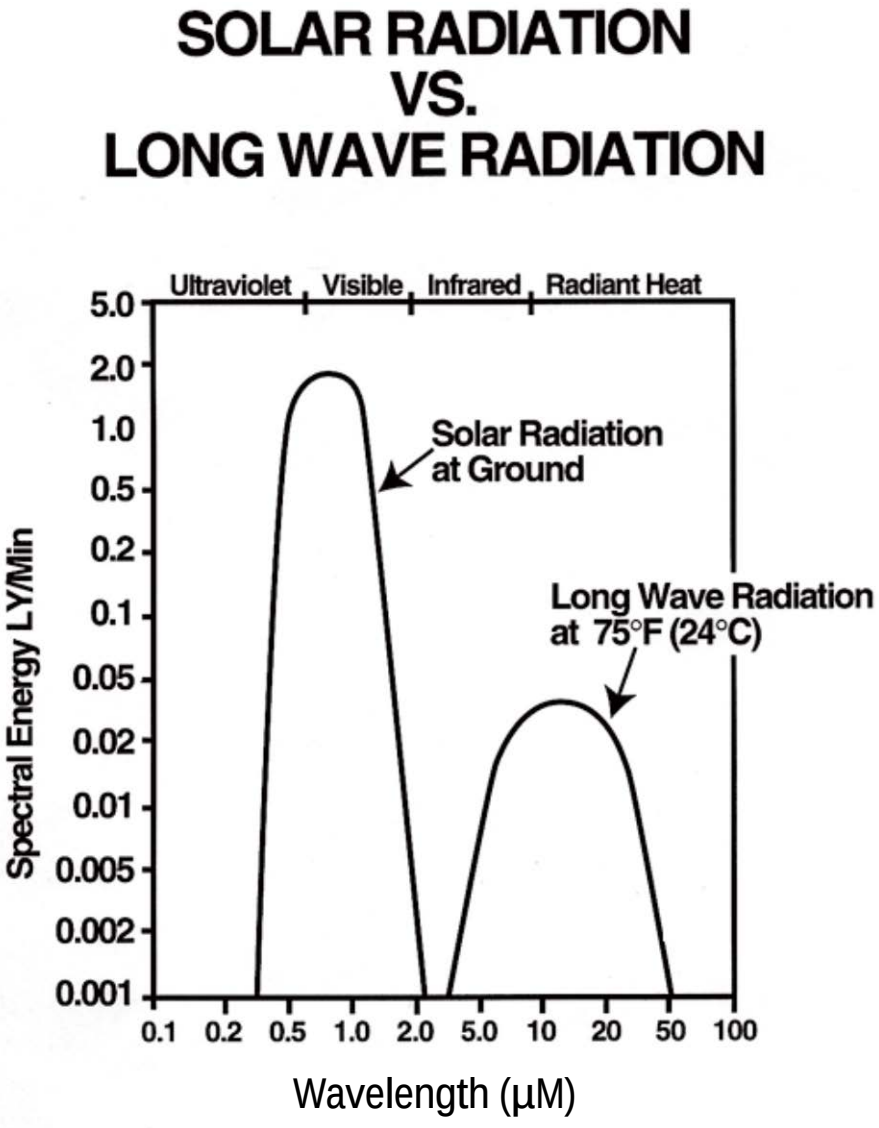
3M™ Window Film
General Information



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3M™ Window Film
General Information

Calculating Solar Energy Reductions

Total Solar Energy Rejected (TSER) = 1 – Solar Heat Gain Coefficient (SGHC)

Formula	Example Low E 35 (LE35)	
Solar Heat Reduction		
(Shading Coefficient of Glass) - (Shading Coefficient of Glass with Film)	0.94 - 0.29	= 69%
Shading Coefficient of Glass	0.94	
Heat Loss Reduction		
(U-Value of Glass) - (U-Value of Glass with Film)	1.06 - 0.74	= 30%
U-Value of Glass	1.06	
Glare Reduction		
(Visible Light Transmission of Glass) - (Visible Light Transmission of Glass with Film)	88 – 31	= 65%
Visible Light Transmission of Glass	88	
UV Blocked		
(100% Total Ultraviolet) - (UV Transmission of Glass with Film)	100-1	= 99%
100% Total Ultraviolet	100	

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3M™ Window Film
Frequently Asked Questions (FAQ)

1. How do 3M Sun Control Window Films work?

3M™ Sun Control Window Films are designed to help reduce the amount of solar heat transmission through window glass by increasing the solar reflection (not necessarily visible reflection) and solar absorption through the glass. Typical colored or dyed films work primarily through increased absorption. The color absorbs the solar energy at the glass, thus reducing the direct transmission into the room. These films offer only marginal performance when compared to reflective films.

Reflective films are films that have been precision coated with metals. These metalized films are designed to increase the solar energy reflection of the glass and some of the absorption. 3M™ Sun Control Window Film reflective films range from moderate to excellent in solar performance (heat gain reduction).

All 3M™ Sun Control Window Films are made to be transparent and optically clear. The ultraviolet protection in the adhesive system is there to protect the adhesive, the metals, the polyester film, and the abrasion resistant coating from UV degradation. This UV protection will also help protect what is behind the film (home and office furnishings), too.
All 3M™ Sun Control Window Films are protected with our patented abrasion resistant coating for long term durability and maintained appearance.

2. How do 3M™ Sun Control All Season (LE) Window Films work?

3M™ Sun Control All Season Window Films, or Low E films work much in the same way as the Sun Control Window Films except that they offer an increased performance against cold weather heat loss. The patented constructions of these films enable the metal coating to reflect more of the interior room heat back into the room where it is needed. This improves comfort by reducing potential draft feelings near the window, and may also save on energy costs, especially in commercial buildings. The LE films are also protected with our abrasion resistant coating for long term durability and maintained appearance.

3. Why do customers have 3M™ Sun Control Window Film applied to their buildings?

- Improved tenant comfort
- Lower heating and cooling operating costs and/or extend A/C equipment life
- Lower utility demand costs
- Utility rebates
- Improved aesthetics, uniform appearance
- Improved safety and security
- Sustainable alternative to adding more A/C equipment
- Reduce rate of fading

Quite often, our customers will purchase 3M™ Sun Control Window Film window films for tenant comfort and justify the purchase on energy cost savings.

4. What is the typical energy pay back for 3M™ Sun Control Window Films?

Simple pay backs will vary depending upon the amount of sunlit glass exposure, the type of film, the type of glass, cost of fuel, cost of application, and other variables. However, we have often seen pay backs in the 2-5 year period, with some reported to be even less than 6 months.

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3M™ Window Film
FAQ continued

5. How are 3M™ Sun Control Window Film applied?

3M™ Sun Control Window Films are professionally applied by skilled, well-trained authorized 3M Dealer personnel. We have films for both interior and exterior applications, and our 3M Authorized Window Film dealers can help you determine which film would be best for your application. The first step is to prepare the window area for the application, placing drop cloths on the floor protecting and/or moving furniture where necessary.

Next, the window glass is cleaned using simple cleaning solutions (often water and ammonia) and razor blade scrapers. Then the film is sprayed with a slip solution (detergent and water) for proper positioning, and applied to the window glass. Using a professional grade squeegee and following proper techniques, the application is completed by removing excess water, trimming the edges, and a final squeegee technique to dry the edges.

6. How long does it take for 3M™ Sun Control Window Films to dry?

We suggest allowing thirty days for the film to fully dry and cure. During this curing process, it is natural to have small water bubbles and/or a hazing milkiness appearance. These will disappear as the film dries; depending upon the film type and weather conditions, drying may take as much as 30 (or even 45) days, or as little as a few days. Once dried, 3M™ Sun Control Window Films will look great and perform well.

7. Can I install 3M™ Sun Control Window Film myself?

No, 3M™ Sun Control Window Films require professional application. Our authorized 3M™ Sun Control Window Film Dealer/Applicators are thoroughly trained and experienced in performing high quality work. In this way, our customers will enjoy the benefits of 3M™ Sun Control Window Films and have the comfort of the 3M™ Sun Control Window Film warranty.

8. How do I clean my 3M™ Sun Control Window Film?

After thirty (30) days, you may clean 3M™ Sun Control Window Films using normal household cleaning solutions, including ammonia based products like Windex®, and a soft, lint-free cloth or towel. You may also use a squeegee to clean the films. Abrasive products will scratch or damage the film and should never be used.

9. How long does 3M™ Sun Control Window Film last?

3M™ Sun Control Window Films are durable and made to last for many years. Just how long a particular film will last depends upon the type of film applied, type of glass it is applied to and the particular climate in which it is applied. Most applications last upwards of 15 years and several applications are still performing after 20 years. All applications have a minimum warranty period of 5 years (except exterior applications which are 2 years), and several films carry a 10-15 year commercial warranty, and even a lifetime residential warranty for as long as original purchaser owns the home.

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3M™ Window Film
FAQ continued

10. How do I remove the old film from my windows?

3M™ Sun Control Window Films are designed to bond the film to the window glass for many years. Yet when it is time to remove the film, removal can be performed by following a relatively simple process.

- First, try to pull the film off by lifting and peeling the film from a corner. If removing the film is difficult, spray the film with a solution of mild dishwashing detergent and water and cover with a plastic film (trash can liners work).Allow to soak for several hours or overnight. Now, try Step 1 again.
- Next, the adhesive residue left on the glass can be sprayed with a sudsy ammonia and water solution and scraped with a four inch razor blade tool equipped with a stainless steel blade.

Unfortunately, not all competitive films are designed for removal. They can prove to be particularly difficult to remove and may require more drastic measures.

11. What is the warranty for 3M™ Sun Control Window Film?

3M™ Sun Control Window Films are warranted to maintain their solar properties without bubbling, peeling, cracking, or crazing. Many of our films are warranted against discoloration, too (those which do not use dyed polyesters). Should the product prove to be defective, 3M and the authorized 3M™ Sun Control Window Film dealer will replace the film and provide the reapplication labor free of charge.

In addition, the 3M™ Sun Control Window Film warranty includes 60 months glass breakage coverage for all qualified applications. Should your glass break due to thermal shock, 3M will replace the glass (maximum $500.00 per window) and the dealer will replace the film.

The length of the warranty is determined by film type and market (residential or commercial). 3M commits to writing the terms of all film warranties in our brochures and consumer publications. For more details, please contact your local authorized 3M dealer/applicator and/or distributor.

12. Do 3M™ Sun Control Window Films cause glass to break?

3M™ Sun Control Window Films will increase the temperature of your sunlit glass, which will in turn; increase the stress on the glass edges. The quality of the glass edge and several other factors (external shading, interior shading, glass history, type of film, size/shape of glass, indoor/outdoor temperature) all contribute to the risk of glass breakage.

3M's forty plus years of experience with applying 3M™ Sun Control Window Films to different types of glass enables us to make proper film/glass recommendations and reduce the potential for glass breakage. In addition, we support these recommendations with our five year glass breakage warranty against thermal shock fracture. Should the glass break within five years of application, 3M will replace the glass (maximum $500.00 per window), and the dealer will replace the film.

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3M™ Window Film
FAQ continued

13. Do 3M™ Sun Control Window Films cause seal failure when applied to insulated (double-pane, Thermopane™) windows?

No, 3M™ Sun Control Window Films do not cause seal failure. We've been applying 3M™ Sun Control Window Films to insulated windows for over 40 years, having seen several millions of square feet of film applied to date.

When recommended films are applied to the inside pane of an insulated glass unit, there will be some absorption (except with clear safety films) of the sun's energy, which will increase the temperature of the glass pane. Some of this heat will transmit to the airspace, slightly raising the airspace temperature. However, even a 20 F degree increase (unusual for most films) will result in a less than 3% change in air pressure. Properly made windows are designed and tested to withstand 22% changes in air pressure.

Risk of seal failure is determined largely by the quality of workmanship and the quality of the materials that go into building the insulated glass units. The best guard against seal failure is to purchase well-made windows from reputable manufacturers that have solid experience and histories with insulated windows.

14. Will 3M™ Sun Control Window Film stop my furnishings from fading?

Nothing stops fading. 3M™ Sun Control Window Films are designed to help reduce the major causes of fading (ultraviolet light, visible light, and solar heat), thus helping to prolong the life and preserving the appearance of your furnishings.
As a general rule of thumb, Ultraviolet (UV) is approximately 40% of the cause of furniture fading, visible light about 25%, and heat about 25%.The remaining 10% can be attributed to humidity, pollutants, interior lights, dye anchorage, and other causes.

15. Does the ultraviolet protection lose its effectiveness over time?

No, the ultraviolet (UV) protection that we use in our proprietary adhesive system does not lose its effectiveness over time. In fact, we tested an actual glass sample from The Dumbarton House, Washington, DC. This was a ten (10) year old application and the Ultraviolet transmission still measures <1%!

16. How do 3M™ Safety and Security Window Films work?

3M™ Safety and Security Window Films are designed to make glass shatter-resistant by holding the glass pieces together when broken. Different from 3M™ Sun Control Window Film, 3M™ Safety and Security Window Films are made with thicker polyester and a much thicker, more aggressive adhesive system. 3M™ Ultra Safety and Security Window Films are unique in the industry: they are built using a special micro-layered polyester technology which increases the film's tear resistance significantly. The impact and tear resistance of 3M™ Ultra Safety and Security Window Films outperform other films of similar thickness known to 3M.

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3M™ Window Film
FAQ continued

17. Are 3M™ Safety and Security Window Films hurricane-proof? Bullet-proof? Burglar-proof?

No, 3M™ Safety and Security Window Films are not hurricane-proof, earthquake-proof, bullet-proof, bomb-proof, nor burglar-proof. No films ever could be. They do, however, make the window glass more shatter-resistant. In the event of a wind storm, these films may have significant safety and security value. They can help reduce the risk of injury from flying shards of broken glass, and possibly help prevent debris and water penetration through the window depending on the severity of the storm (and the type of glass, framing system, size and velocity of objects, and more).

In an earthquake, these films can help reduce the risk of serious injury from flying shards of broken glass, and possibley prevent glass from falling out of a home or building. Again, much may depend upon the severity of the quake (and the type of glass, framing system, and more, too).

Bullets: these films are not designed to stop bullets. The consumer should be cautious of any film manufacturer claiming their product to be bullet proof or bullet resistant. In certain situations, 3M Safety and Secuity Window Films may be applied to bullet resistant glazing – glass that is already rated to stop a specific class of bullets – to serve as an anti spall layer to prevent slivers of glass (or "spall") from projecting.

3M films were originally developed due to the international concerns and needs for improved safety and security against terrorist acts of bombings. These films can significantly reduce the risk of serious injury from flying shards of glass due to blasts, however, much depends upon the severity of the blast and the proximity of the window glass to the blast (and glass type, framing system, and more too). Due to their tear resistance, flexibility and energy absorbing and dissipation properties, certain 3M Ultra Safety and Security Window films work particularly well at mitigating blast hazards.

3M™ Safety and Security Window Films are a low-profile, easily implemented measure of security in the battle against 'smash and grab' crime. The tough, shatter-resistant qualities of the film can hold the window glass together even if a brick (or similar object) were actually to pass through the glass. With use of a 3M Impact Protection Attachment system, the intruder is forced to create an opening through the filmed glass to which to pass. The thief must now make a choice; continue to attack this window, try another window, or move on. Time is short, and often they move on. However, if they are determined to gain entry, they will get in. It is generally recommended that the property have proper alarm systems in addition to 3M™ Safety and Security Window Film.

18. Will 3M™ Safety and Security Window Films keep my glass from breaking?

No, 3M™ Ultra Safety and Security Window Films are designed to hold broken pieces of glass together in the window opening after a break. This helps reduce the chance of injury from flying shards of glass, makes it more difficult to break in through a window, as well as increases safety and security in the event of a windstorm or bomb blast.

When glass breaks, 3M™ Safety and Security Window Film demonstrates its best performance!

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3M™ Window Film
FAQ continued

19. How do I find the nearest authorized 3M™ Sun Control Window Film dealer? Or, is XYZ Tinting a 3M Sun Control Window Film dealer?

The simplest way is to contact 3M directly for the name of the nearest 3M Distributor 1-800-480-1704. We would be able to provide you with an up-to-date listing of the Authorized 3M™ Sun Control Window Film Dealer/Applicator in your area. They can confirm which businesses are Authorized 3M dealerships.

20. Will 3M™ Window Film help sound-proof my windows?

No, our window films do not have significant sound insulating properties.

21. Will 3M™ Window Film dampen the sound of broken glass?

Only to the extent that sound generated from falling fragments is reduced. Generally, the sound of initial glass breakage is unaffected. In fact, it is preceisely for this reason that 3M™ Safety and Security Window Films work well in conjuction with alarm system that are based on the sound of glass breaking – they do not interfere with their glass break sensors!

22. Can 3M™ Safety and Security Films be used for Safety Glazing (ie, in place of tempered glass)?

Some of our films are used for this purpose. Applicability depends on several factors. Contact your 3M Technical Service Respresentative for more information.

23. Can 3M™ Window film be applied on tempered glass?

Applying film to tempered glass may be beneficial; for example, to help secure glass fragments and protect from spontaneous glass breakage. However, it is recommended that filming tempered glass involve an attachment system due to the small fragmentation break pattern of tempered glass and increased risk that the filmed / broken glass panel would dislodge from the frame entirely.

24. Can Impact Protection Adhesive or Profile be painted?

Yes, IPA and IPP can be painted after they have had sufficient time to cure and achieve full adhesion. Painting their surfaces should not affect their performance. However, 3M generally discourages making any post installation modifications and the consumer should accept all liability.

25. Can Impact Protection Adhesive or Profile be applied to painted or finished surfaces?

Yes, but adhesion to that surface will be only as strong as the paint bond to that surface. 3M generally recommends against applying IPA or IPP to painted residential surfaces. In commercial applications, it is advisable to conduct an adhesion test to painted surfaces prior to purchasing the IPA or IPP.

26. Can Impact Protection Adhesive or Profile be applied to wood surfaces?

Impact Protection Profile: No.
Impact Protection Adhesive: Yes, but the consumer should consider all aspects of aesthetics and function.

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3M™ Window Film
FAQ continued

27. Can Impact Protection Adhesive or Profile be applied to vinyl surfaces?

There is a wide variety of vinyl formulations that can result in different surface energy. It is recommended that an adhesion test be conducted to all vinyl surfaces prior to purchasing the IPA or IPP.

28. Can Impact Protection Adhesive or Profile be used for outdoor applications?

Yes, both these products are weatherable and can be used for exterior applications.

29. Can Impact Protection Adhesive be reapplied over itself once cured?

Yes, IPA can be applied over itself to thicken a bead or when replacement is needed. This is one of the advantages of 3M™ Impact Protection Adhesive over common structural silicone sealants.

30. Should an attachment system be used on french pane windows?

First consideration should be given to the intended application and code and/or specification requirements. Many projects require proof of performance testing on the specific window system including glass, size, frame, anchorage, etc. Secondly, our impact protection attachment systems are primarily used on commercial windows, not residential windows with intricate and decorative frame mullions. The consumer should be made aware of what to expect when considering having an impact protection film attachment system applied to windows on their home.

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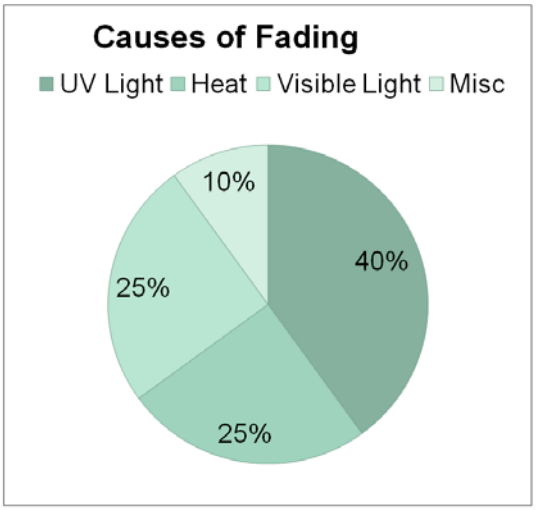
3M™ Window Film
UV Protection and Fading

3M Solar Films help protect against harmful ultraviolet (UV) radiation. While UV radiation only makes up approximately 3% of solar energy, it contributes up to 40% of fading and is linked to premature aging of skin and melanoma, a deadly form of skin cancer.

Breakdown of UV Radiation:

- UV-C: 200-290 nm wavelength is blocked by the atmosphere.
- UV-B: 290-320 nm wavelength, intensity varies by time of day and is blocked by glass
- UV-A: 320-380 nm wavelength, always present and is blocked by 3M Window Film.

CAUSES OF FADING:	3M NV35 on single pane clear
	• Reduce UV > 99% • Reduce Visible Light 64% • Reduce Heat Gain 41% • Does not affect Miscellaneous o Artificial Lighting o Dye Type/quality o Humidity o Air contaminants

It is important to note that 3M Window Films help reduce the speed of fading. They do not completely stop fading.

The following photographs show fading when the black fabric is protected with a window film compared to plain glass.

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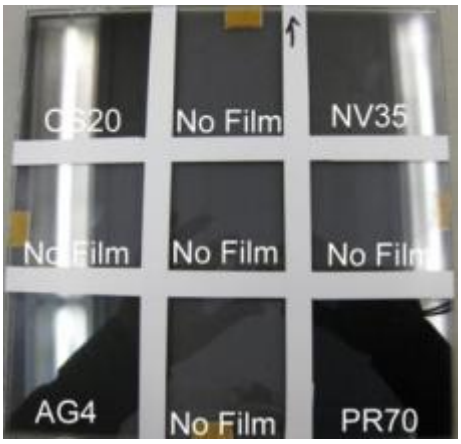
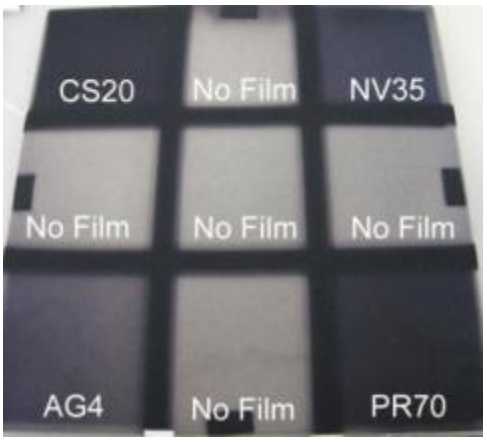
3M™ Window Film
UV Protection and Fading Continued





In addition to helping reduce the rate of fading, and more importantly, reducing exposure to UV radiation can help reduce the probability of premature aging of skin and of developing skin cancer.

The following page shows the Skin Cancer Foundation's Seal of Recommendation.

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3M™ Window Film

My Sun Protection Products

Brand	Product	Seal Type	SPF Rating	Application
3M Company	Sun Control Window Films	Traditional		
3M Company	Safety & Security Window Films	Traditional		
3M Company	Automotive Window Films	Traditional		

Glossary of Sun Protection Terms:

UVA Rays: Ultraviolet rays that cause lasting skin damage, skin aging and may cause skin cancer.

UVB Rays: Ultraviolet rays that cause sunburn and may cause skin cancer.

SPF: A sunscreen's Sun Protection Factor (SPF) is a measure of its protection against UVB rays.

Broad Spectrum: Protection against UVA and UVB rays.

UPF: Ultraviolet Protection Factor (UPF) indicates how much of the sun's UV radiation is absorbed by a sun protective fabric.

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3M™ Window Film
Storage Conditions

Recommended storage conditions for all films are printed on the box. They are 70° F (21° C) and 40 - 50% relative humidity. Avoid extreme temperature ranges in storage conditions.

The shelf life of film is dependent on many factors including but not limited to:

1. Film material
2. How tightly the film is kept on the roll
3. Storage conditions including
    a. Heat
    b. Light
    c. Humidity
4. Keeping the original packaging

To ensure the longest shelf life possible be sure to store the film according to the guidelines given in each box of film. The 3M recommended shelf life for the film is 5 years, however, we would expect that the film will last much longer. A few best practices to determine whether a film has degraded over time would be to compare the old film to a newer roll, read the UV, Visible, and IR transmission of the film and compare to published specs, and to do a visual inspection in both reflected and transmitted light of the first 10 feet of film.

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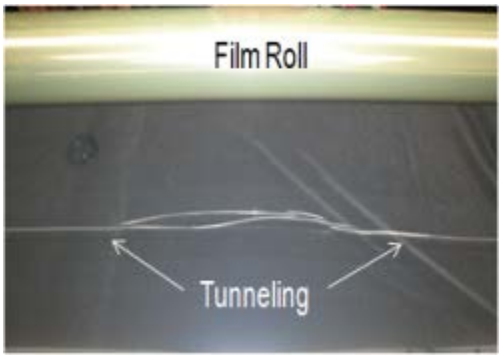
3M™ Window Film

Storage & Handling of Safety Films

Best Practices for Preventing Tunneling

While 3M window films are designed to maximize ease of installation without compromising product quality, improper storage and handling of the film can impart visual defects – known as tunneling -- that could make the film unusable. Tunneling occurs when a section of the film liner prematurely releases from the adhesive, resulting in a streak running across the film. It is important to understand common causes for tunneling and other handling related defects, as well as best practices that can be easily implemented to prevent them.



Film Inspection. When unpackaging a roll of new or previously used film, inspect its condition before going to the job site when possible. Make sure the film is tightly wound and taped well. Inspect the wound film at both ends of the roll – if the film appears loose throughout any part of the roll, there is increased risk that liner separation and tunneling has occurred at this location.

Roll Tension. Maintaining roll tension is critical to preserving film quality and avoiding tunneling. This is especially true for security films due to substantial differences in thickness and rigidity between the adhesive liner and security film. Film Handlers are a preferred method of dispensing the film, in part because of the ease and effectiveness in which they maintain good roll tension. If not using a film handler and manually dispensing film out of the box, pay special attention to the roll tension. Never let the unused film sit in the box for an extended period of time without rolling it tightly and securing with tape. When securing leftover film, a good practice is to inspect both ends of the film roll and visually verify roll tension before storing.

Taping. Once leftover film has been wound tightly, proper taping is essential to maintaining tension and preserving film quality. If the tape splits or fails, the film can suddenly lose tension and cause tunneling defects throughout the entire roll. Use a tape with a strong enough backing so that it won't split or tear during storage or shipping. Apply tape in 3 locations (4 locations for 72" film) along the roll: two no more than 6" from the ends, and one (or 2) in the middle. Apply the tape in the same direction as the film is wound. A good practice is to wrap the tape completely around the roll so that it sticks to itself.

Pre-cutting film. It is common practice for film installers – especially for small jobs or those entailing very thick security films – to pre-cut the film well in advance before it is actually applied to the glass. While this may offer some installation convenience, the film is very susceptible to tunneling if not handled and stored properly. When preparing pre-cut rolls of film (with no core supporting it), never roll to less than 2.5" in diameter. Winding to too small a diameter can cause liner tunneling to occur immediately. Also, wind the film with the liner side out, which will greatly reduce chances of tunneling. Tape securely as described previously, but additionally wrap a piece of tape across the outer and inner diameter at both ends of the film roll to help prevent the film from telescoping or tunneling. Lastly, ensure that pre-cut film rolls are well protected. Store them inside film cores to protect them from getting crushed or damaged, again keeping in mind that the film should not be would to too small a diameter.

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3M™ Window Film
Tech Bulletin: Iridescence

Iridescence Effect in Window Films

Under certain lighting conditions and viewing angles, window films can, at times, exhibit a “rainbow effect” or an "oil on water” appearance on the surface, referred to as **iridescence** (Figure 1). The coloration is not from dyes or other color substances rather it is due to the multilayer structure of window films. Iridescence manifests as varied colors and is the result from the interference of light waves reflected from different surfaces within the film, and changes with the angle of view. In the case of window films, the scratch resistant hardcoat (surface 1) applied over the polyester film (surface 2) is responsible for the iridescence. While the hardcoat is optically clear, it has a slightly different refractive index than the underlying polyester film. As depicted in Figure 2, when incident light hits the hardcoat (i.e., light from the interior of the room), some of the light transmits through to the exterior of the window and some of the light is reflected off the hardcoat and back into the interior of the room (λ_1). Additionally, light is reflected off the underlying polyester layer and back again through the hardcoat (λ_2). Variations in the reflected light waves across the surfaces of the film produce the iridescence effect.

Figure 1. Iridescence (seen in this image as multicolored streaks running horizontally) on film under fluorescent lighting. Image altered to accentuate the effect.

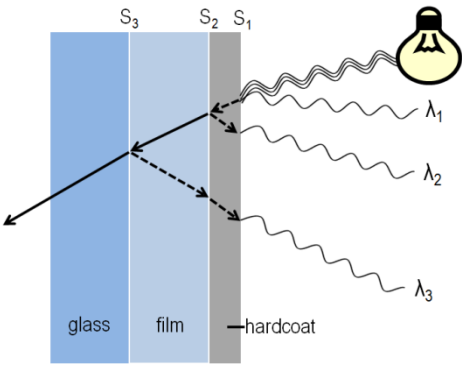

Figure 2. Light passes through different media and reflects back at different wavelengths, causing iridescence.

The most common source of iridescence is artificial lighting, particularly fluorescent lighting. Fluorescent light emits discrete wavelengths of light instead of a continuous spectrum of light which can make the iridescence appear much worse. Also, iridescence can be amplified under certain viewing conditions, such as with darker external backgrounds like nighttime and with sloped glass. The best way to reduce iridescence is to use a full spectrum light source like incandescent lighting or full spectrum LED lighting.

Iridescence is not a sign of product failure or deterioration.

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3M™ Window Film

Electromagnetic Interference (EMI)

BACKGROUND AND DEFINITIONS

Basic Background Information

1. Why are we involved with EMI Shielding?
    a. Customers have asked if our 3M™ Sun Control Window Films will block radio waves or microwaves
    b. Some of our current competitors claim that their products work for this application
2. What is EMC, EMI and EMIC?
    a. EMC - Electromagnetic Compatibility - Electrical devices have EMC when the electrical noise generated by each device does not interfere with the normal performance of the other device
    b. EMI - Electromagnetic Interference - EMI is said to exist when undesirable voltage or currents adversely affect the performance of a device
    c. EMIC - Electromagnetic Interference Control - The process of making design changes or adjustments of signal or noise levels is called EMIC
3. What is EMI and EMIC?
    a. When electricity flows it generates electromagnetic waves
    b. The wavelength and frequency of the wave determines where these waves are classified in the Electromagnetic Spectrum
    c. EM waves can interfere with the performance of electronic devices
    d. All electronic devices generate EMI.
    e. Grounding or adding filters is an EMIC method.
4. Why is EMIC necessary?
    a. Protect electronic equipment from destructive outside interference such as:
        1. High power transmitters (radar, FM, etc.)
        2. Nuclear effects - electromagnetic pulse (EMP)
        3. Lighting
    b. Protect electronic equipment from temporary equipment malfunctions
5. How is the EMI shielding achieved?
    a. EM waves (fields) are reduced (attenuated) through absorption or reflection by conductive surfaces (shields)
    b. b. The most effective shields are metallic and electrically conductive
    c. c. How well the shield attenuates the field is called its shielding effectiveness (SE)

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3M™ Window Film
EMI

TEST RESULTS

Shielding Effectiveness for 3M™ Films

Tested according to ASTM D 4935, “Standard Test Method for Measuring the Electromagnetic Shielding Effectiveness of Planar Materials.” This is a far field test measurement taken using a coaxial cell. The dynamic range indicates the maximum measurement capability of our test setup, in other words the response of a “perfect” shield.

Frequency

Product	30 MHz	100 MHz	300 MHz	1 GHz	2.5 GHz	4.5 GHZ
Silver P18ARL (P-18ARL)	24 dB	22 dB	22 dB	24 dB	26 dB	27 dB
RE15SIXL	24 dB	23 dB	23 dB	25 dB	26 dB	28 dB
Neutral 35 (RE35NEARL)*	7 dB	7 dB	7 dB	7 dB	7 dB	8 dB
Low E 35 (LE35)	41 dB	35 dB	32 dB	33 dB	43 dB	34 dB
NV25*	11 dB	11 dB	13 dB	12 dB	13 dB	14 dB
Prestige series	No emi attenuation measured					
Dynamic Range	97 dB	97 dB	97 dB	97 dB	93 dB	86 dB

*Negligible shielding properties

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3M™ Window Film
Effects on House Plants

Effects on House Plants with 3M™ Sun Control Window Film Applied On Glass

KNOWN FACTS

1. Growth and development requirements vary with different plants
2. Growth and development depend upon light, temperature range, exposure, humidity, CO2 levels, etc.
3. For sufficient growth, the wavelength of 400-700 nm is important for photosynthesis (greening process)
4. 700-850 nm range is required for the photomorphogenic process (flowering process)
5. Most greenhouses have artificial light to supplement natural light (day vs. night, summer vs. winter, cloudy vs. sunny)
6. UV is damaging to most green plants
7. Extreme temperature variations are detrimental to plant growth
8. 3M Sun Control Window Film will help reduce solar heat gain, temperature buildup and moisture loss (Plants may require less water after film is installed, so care should be taken not to drown plants from over watering.)

WHAT TO DO WHEN IN QUESTION?

Contact a local horticulturist, college or university extension office

- Provide type of plant(s)
- Provide percent reduction of visible light, UV and solar heat with specific 3M™ Sun Control Window Film applied to glass
- Consult your local Agricultural Extension agent

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3M™ Window Film
Glass Types

Primary Glass Products

FLOAT GLASS

The Float Glass Process accounts for over 90% of the flat glass presently produced in the United States. In this process, molten glass is poured continuously from a furnace onto a large bed of molten tin. The molten glass literally floats on the tin, spreading and seeking a controlled level in the same manner as water poured onto a smooth, flat surface.

In the controlled level seeking process, the molten glass is allowed to spread to width of 90" to 140," depending upon the furnace size and glass thickness being produced. The glass slowly solidifies as it travels over the molten tin. It then enters an annealing lehr where the cooling process continues under controlled conditions. After several hundred feet of travel through the lehr, it emerges as a continuous ribbon of glass at essentially room temperature. The product is now flat, fire-finished, and with virtually parallel surfaces.

CLEAR GLASS

Clear glass consists of silica sand with added alkaline salts such as lime potash and soda. It is colorless and has a visible light transmittance ranging from 75% to 92%, depending upon thickness. It constitutes the bulk of the flat glass that is used.

TINTED/HEAT ABSORBING GLASS

Tinted or Heat Absorbing Glass is made by adding various colorants to the normal, clear glass batch to create a desired color. The four colors available by the Float Process and Bronze, Gray, Green and Blue. Visible light transmittance will vary from 14% to 83%, depending upon color and thickness. The color density is a function of thickness, and increases as the thickness increases; visible light transmittance will decrease as thickness increases.

Tinting reduces the solar transmittance of glass, has little effect upon solar reflectance, hence increases solar absorption (heat). This explains why heat strengthening or tempering is sometimes required for the thicker tinted glasses. Adding a metallic coating also has the same effect on thinner glasses.

ASTM Specification C1036-85 separates Heat Absorbing and Tinted (light reducing) glasses into separate categories based upon the maximum solar energy transmittance, by glass thickness. Nevertheless, all tinted glass is heat absorbent, to one degree or another. The Bronze, Gray, Green and Blue tints produced by the Float Process are all classed as heat absorbent.

SHEET GLASS

The Sheet Glass Process accounts for a very small portion of U.S. production. Some imported sheet glass will continue to be used, mainly in thickness of 1/8" and less.

PLATE GLASS

Plate Glass, manufactured by the grinding and polishing process, is no longer produced in the United States, and words referring to it have been eliminated from the ASTM Specification C103685. It has been replaced by the float glass process.

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3M™ Window Film
Glass Types

Primary Glass Products (continued)

ROLLED GLASS

The Rolled Glass Process consists of pouring molten glass from a furnace, then feeding it through rollers to produce the desired thickness. The glass ribbon then enters a lehr where the cooling continues under controlled conditions. There are three general types of rolled glass: figured/patterned, wired and art/opalescent/cathedral glass.

FIGURED/PATTERNED GLASS

Figured/Patterned Glass is produced domestically by the continuous pour process in thickness of 1/8" to 7/32". A pattern etched on one or both of the rollers is reproduced on the glass. Colors are available but extremely limited.

This type of glass is frequently called "obscure" or "decorative" glass. The pattern diffuses detail of objects viewed through the glass, it does not obscure them. The degree of diffusion achieved is a function of the pattern and whether the pattern is on one or both sides.

Some patterns cannot be tempered for safety glazing use because of their depth.

WIRED GLASS

Wired Glass is produced on the same equipment as is Figured/Patterned glass. A welded wire netting or parallel wires are introduced into the molten glass just before entering the rolls, thus embedding the wire into the glass. Patterned wired glass has pattern on one or both sides, and is sometimes called "rough" wired glass. Polished wire glass is produced by grinding and polishing rolled wired glass blanks.

Tinted/Heat Absorbing wired glass is available only from suppliers outside the U.S. The heat absorbing characteristic in conjunction with the normally poor cut edges and the wire netting can cause a high rate of breakage from thermal stress, especially in non-vertical applications.

The major use of wired glass is in institutional buildings and fire rated windows and doors. All wires must be completely embedded in the glass. Some misalignment of the wires may be noticeable, but this is not considered cause for rejection.

Wired glass cannot be tempered. From a windload standpoint, it is considered to be approximately 50% as strong as annealed glass of the same thickness.

The edges of wired glass should be sealed from water to prevent rusting of the embedded wires. This can be accomplished either by physically sealing the perimeter of the lite with a sealant or by glazing in such a manner that the glazing rabbet will always remain dry. The iron oxide molecule is larger than the iron molecule, so rusting of the wires will cause glass breakage.

Most Building Codes require that wired glass meet NFPA 80 or be classified by U.L. as fire resistant glazing when used in fire doors or windows. Wire glass does not meet the requirements of CPSC 16 C.F.R. Section 12301, hence cannot be used as a safety glazing material in situations governed by that regulation.

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3M™ Window Film
Glass Types

Primary Glass Products (continued)

ART/OPALESCENT/CATHEDRAL GLASS

Colored translucent glass, often called art glass, opalescent glass, cathedral glass or stained glass, is also produced by the rolling process, but generally in small, batch type operations. There are usually variegated colors within each sheet produced and no two sheets will match for hue. Thickness will vary within a sheet as well as from sheet to sheet. The maximum thickness produced is usually 1/8."

When used as a glazing material, art glass should be glazed in the same manner as tinted/heat absorbing glass. Art glass cannot be tempered.

Fabricated Glass Products

INSULATING GLASS UNITS

Double insulating glass units consist of two panes of glass that enclose a hermetically sealed air space. The panes are held apart by a spacer around the entire perimeter. The spacer contains a moisture absorbent material called a desiccant that serves to keep the enclosed air free of visible moisture. The rubber-like material that produces the hermetic quality of the unit. Some manufacturers use non-curing sealant.

CERTIFICATION

The purpose of a certification program is to assure the user that the purchased product is a faithful replica of one that has successfully passed certain prescribed tests. Participants in a certification program must therefore, a) submit their products to independent testing laboratories for the prescribed tests b) agree to periodic, unannounced inspection of their regular production by an independent agency to insure that actual production employs the same materials and techniques as the tested specimen.

For insulating glass manufacturers there are two competing certification programs available. One is conducted by Associated Laboratories, Inc. (ALI), which also conducts a companion certification predominantly window and door manufacturers who fabricate insulating glass for use in their own products. The second program, the Insulating Glass Certification Council (IGCC), is an independent, non profit organization whose management is vested in a Board of Governors made up equally of industry and public interest members. All IGCC meetings are open to the public.

Further information can be obtained by writing or telephoning :

Insulating Glass Certification
Route 11 Industrial Park
Cortland, New York 13045
607-753-6711

Associated Laboratories, Inc
P.O. Box 15705
1323 Wall Street
Dallas, Texas 75215

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3M™ Window Film
Glass Types

Fabricated Glass Products (continued)

DISTORTION

The air (or gas) sealed within an insulating glass unit will respond to the Gas Laws of Physics from the moment the unit is sealed. These laws govern the volume of gas as related to various temperature and pressure conditions. As the sealed-in air is heated or cooled, it expands or contracts. As the barometric pressure falls or rises, it likewise expands or contracts. This causes the two panes to bow away from or toward each other.

They will be in virtually constant motion, hence seldom ever parallel (flat). When the glass is in a reflecting mode, the objects reflected will appear distorted. There is no known method by which precisely the same internal temperature and barometric pressure can be simultaneously achieved for each and every insulating unit on a specific project and still have the advantages of a sealed unit.

RETROFIT

Several systems have been developed to convert single glass into insulating glass in existing buildings. These systems involve cleaning the interior of the existing glass, applying a desiccated spacer, a second (new) pane of glass and a perimeter sealant. This generally works best on fixed (non-operable) windows. Optimum performance is generally achieved by using reflective glass. Since every project is custom, warranties can vary as can capabilities of insulator since this is field, rather than factory assembly.

WARRANTIES

Since no two insulating glass manufacturers use the same combination of components and fabrication techniques, no two warranties are alike. Warranties usually require adherence to certain installation procedures or techniques and exclude glass breakage and the replacement glazing labor.

REFLECTIVE GLASS

Reflective glass is a clear or tinted glass coated with an extremely thin layer of metal or metallic oxide. The coatings are thin by design; otherwise they could not transmit light. Dependent upon the desired level to visible light transmission, the coating thickness is generally in the range of .000001" to .000004". Installed in a building, reflective glass imparts a mirror-like appearance to the exterior under most daytime conditions. It reduces heat gain and glare from the exterior and allows visible light transmission to the interior. The major advantages of reflective glass are

a. Aesthetic Appeal: The various silver, copper, golden and earthtone reflective coatings, when combined with clear, bronze, gray, green or blue tinted float glass, allow the architect more flexibility in exterior design than with uncoated glass types alone.
b. Energy Savings: Through its ability to reflect and absorb radiant solar heat, reflective glass will substantially reduce interior solar heat gain. The added cost of reflective glass will generally be offset by the size and cost reduction in the heating and cooling system.
c. Occupant Comfort: Occupant comfort is improved when heat gain/loss differentials between sunny and shaded elevations are substantially reduced. Interior temperature variations are thus less and easier to control.

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3M™ Window Film
Glass Types

Fabricated Glass Products

METHOD OF MANUFACTURE

There are three methods of coating deposition used in the manufacture of reflective glass:

a. Wet Chemical Deposition: This is simply the precipitation of a metal from a chemical solution by a reagent. The reaction occurs uniformly in a thin film on a horizon piece of glass instead of in a laboratory test tube. The film thickness is closely controlled to produce a desired level of light transmission. Coatings produced by this method are generally fragile, and must be immediately protected, usually by incorporating into an insulation glass or laminated glass product.

b. Vacuum Deposition: This method involves a large vacuum chamber, vacuum pressures, an inert gas atmosphere and electrical energy. The electrical energy imparts a negative charge to the atoms of inert gas. The vacuum pressure, which is on the order of .0006 to .000006 psi (compared to 14.7 psi, normal atmospheric pressure), allows the negatively charged gas atoms to move freely at a high velocity. When they strike a metal cathode, atoms of the metal are dislodged, also at a high velocity. When they strike a metal cathode, atoms of the metal are dislodged, also at a high velocity. The metal atoms then impinge upon the glass substrate, creating the thin, metallic coating. Coating hardness and adhesion is a function of the metal or alloy used and of the particle speed at impact. Many vacuum deposited coated glasses can be used monolithically; or can be readily shipped to another location to be fabricated into laminated or insulating glass product.

   Coated glasses produced by wet chemical or vacuum deposition methods cannot be tempered or heat strengthened after coating since this would destroy the coating. When used on a tinted glass substrate, tempering or heat strengthening is required because the reflective coating increases the solar absorption. Some coatings make clear glass so highly absorbent that the need for heat strengthening or tempering should be investigated prior to specification and purchase. A good rule of thumb is to investigate the need to heat treat any glass where the absorption of radiant solar energy is greater than 50%.

c. Pyrolitic Deposition: This process applies a metallic oxide coating to hot glass (usually tinted). Pyrolitic deposition can be accomplished in a properly equipped heat strengthening oven, or on a float glass line near the hot end of the lehr. The metallic oxide is literally impregnated into the soft, cherry-red surface of the glass. Annealed glass with a pyrolitic coating side to the weather (to the outdoors). Since the radiant solar energy is substantially rejected by the coating before it enters the glass substrate, heat strengthening or tempering may not be required in many instances where it would be required for other types of reflective glass.

PERFORMANCE

Another way to classify reflective coatings is by the degree to which they reject radiant solar energy. The coatings created by wet chemical or vacuum deposition are usually of higher performance (i.e., have lower shading coefficients) than the pyrolitically deposited coatings of equivalent visible light transmission.
Wet chemical or vacuum deposited coatings have a lower shading coefficient when installed on the second (2nd) surface (vs. the 3rd surface) of an insulating glass unit. Pyrolitic coated glass has the lowest shading coefficient when installed on the 1st surface.

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3M™ Window Film
Glass Types

Fabricated Glass Products

SPECIFICATION

All reflective glasses of the same general color and light transmission are not alike in reflectance level and other solar-optical properties, shading coefficient or U-value. The typical performance specification should state the primary type of glass, desired color of coating and maximum values of light transmission, shading coefficient and winter and summer U-values. Any alternate bids for glass having different values should have a companion alternate in the mechanical specifications if those glass values are sufficiently different as to affect the size (larger or smaller) of the mechanical system

The specifications should include a provision for construction of a full size mock-up incorporating the reflective glass and metal, for viewing and approval by the architect and owner. The mock-up should be located at the job site, thus giving a preview of the reflective qualities, distortions, etc., under real life conditions.

The pinholes, streaking and molting are generally process defects. The various coated glass manufacturers generally publish their criteria for coating quality or will supply their criteria upon request.

Monolithic coated glass, whether simply shipped to an insulating glass fabricator or to a jobsite for use “as-is” may be vulnerable to scuff or rub marks generated during shipment. The monolithically glazed, coated glass may also be subject to scuffs, rubs, cup marks and scratches during and after glazing as well as by building occupants who do not realize that the coating is softer than the glass itself. Glass so used should be handled with greater-than-normal care by the glaziers and protected from the other trades, after glazing, by hanging a clear plastic sheet several inches inboard from the glass.

Anything that scratches glass will scratch a pyrolitic coating; vacuum coatings are not as hard as glass, hence more susceptible to damage.

LOW EMISSIVITY GLASS

The reflective glass heretofore discussed reflects the solar spectrum, that part of the heat spectrum in the 300 to 2100 millemicron range of wavelengths. Low emissivity coatings (low E) reflect that part of the heat spectrum above 3000 millemicrons wavelength that is called “sensible heat”. The heat from hot water or steam radiators and the heat from hot air ducts from a furnace are typical examples of this kind of heat.

These coatings have high visible light transmission. In fact, they are nearly invisible on the glass. The visible light transmission is typically about 20 percentage points below that of an equivalent uncoated glass.

The major attribute of low E insulating units is their sensible heat reflecting character which is apparent from their low “u” values. In northern climates they admit winter sun while reflecting sensible indoor heat back into the building, when both lites are clear glass. In southern climates they reduce glare while reflecting the outdoor heat-of-the-day back out in summer with outboard lite bronze. Low E coatings are applied to glass by vacuum processes and by pyrolitic processes.

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3M™ Window Film
Glass Types

Fabricated Glass Products

TEMPERED GLASS

Tempered glass is fabricated by subjecting annealed glass to as special heat-treating process. The most commonly used process is to heat the glass uniformly to approximately 1150°, then rapidly cool it by blowing air uniformly onto both surfaces simultaneously. The cooling process locks the outer surfaces of the glass in a state of high compression and the central portion, or core, in compensating tension.

The color, clarity, chemical composition and light transmission characteristics remain unchanged. Likewise, compression strength, hardness, specific gravity, expansion coefficient, softening point, thermal conductivity, thermal transmittance and stiffness are unchanged. The only physical property that changes is tensile or bending strength. Under uniform loading, tempered glass is about four times stronger than annealed glass of the same size and thickness, thus is more resistant to thermally induced stresses, cyclic windloading and hail stone impacts.

When broken, tempered glass breaks into a multitude of small fragments of more-or-less cubical shape. Therefore, it qualifies as a safety glazing material under the criteria of Federal Standard 16 CFR 1201 and the American National Standards Institute (ANSI) Z97.1-1984, when so labeled and certified. Spots or blotches may, at times, be visible on tempered glass, especially when viewed through polarizing lenses or in certain types of reflected light. The intensity will vary with lighting conditions and viewing angle. This is caused by the strain pattern induced during the cooling stage, and is not inherently a cause for rejection.

PRODUCTION

There are two basic methods for producing air quenched tempered glass. In one method the glass moves through the furnace and quench hung on tongs in a vertical position; in the other it moves on rollers of stainless steel or high strength ceramic, in a horizontal position. Each method produces some degree of bow and warp, which is an inherent characteristic of all tempered glass. Tong-held glass may exhibit a long arc or “S” curve plus some minor distortion at the tong points. Horizontally tempered glass will have characteristic waves or corrugations caused by the support rollers.

LIMITATIONS

Recommended maximum service temperature for tempered glass is approximately 500° F. Tempered glass, although four times stronger than annealed glass, should not be selected to meet a given design wind load simply because annealed glass of the same thickness will not so meet. The stiffness of annealed glass and tempered glass is the same. Excessive deflection can cause glazing sealant failure, glass breakage by contact of an edge or corner with the framing and occupant discomfort.

Some deep patterns of rolled glass cannot be tempered or, if tempered, will not break in the manner prescribed by 16 CFR 1201 or ANSI Z97.1-1984. Tempered glass cannot be cut, drilled or edged. It should not be sand-blasted or acid etched after tempering. Wired glass cannot be tempered.

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3M™ Window Film
Glass Types

Fabricated Glass Products

HEAT STRENGTHENED GLASS

Heat strengthened glass is fabricated by a process similar to that for tempered glass. Some equipment can produce both. The glass is heated to approximately 1100°F and the cooling process is slower than for tempered glass. The strength developed is about twice that of annealed glass. Bow and warp generally are less evident to the eye than in tempered glass. Heat strengthened glass, compared to annealed glass, has greater resistance to solar-induced thermal stresses, cyclic windloading and hailstones. Heat strengthened glass does NOT meet the criteria for safety glazing materials under 16 CFR 1201 or ANSI Z97.1-1984. The break pattern is similar to that of annealed glass, hence it tends to remain in the opening when broken.

SPANDREL GLASS

Spandrel glass panels are heat strengthened or tempered glasses with a ceramic frit color permanently fused to one of the surfaces. Glass in spandrel areas is not subject to corrosion as are some other spandrel materials. Pleasing esthetics and economies can be obtained using a single framing system for an entire wall.

Glass spandrel panels can also save energy when insulation is placed behind them. The insulation can be adhered directly to the glass or spaced 1/2" to 1" away. When specifications require greater assurance that broken glass will remain in the opening, an open weave glass fiber cloth or a special tape can be adhered to the back of the spandrel panel. Some building codes require this. Test performance requirements can be found in Section 7.12 of ASTM C1048-85.

Scattered pinholes, screen marks and small opaque particles are permissible in the ceramic coating. Spandrel glass should not be used in areas subject to being viewed in transmission. Reflective glass spandrels need to rendered opaque to prevent read-through of the building structure under certain light conditions. In order of effectiveness, the following methods are suggested:

a. A reflective insulating glass unit with a dark gray or black frit on one of the surfaces of the inboard lite. Insulation can be attached directly to, or applied against, the unit.
b. Mount dark gray or black rigid insulation a minimum of 1" inboard from the monolithic reflective spandrel glass, preferably 2" or more from the glass. The air space between glass and insulation should be well weeped to the exterior to avoid condensation and potential staining.
c. Adhere a black polyester, fiberglass , or other type of film to the inboard face of the monolithic reflective spandrel glass. The adhesive must be thoroughly tested, insulation must be spaced back from the film at least 1", preferably 2". The space must be well vented to avoid heat build-up that might cause problems with the film or the adhesive.

NOTE: All glass in spandrel areas should be heat strengthened or tempered.

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3M™ Window Film
Glass Types

Fabricated Glass Products

LAMINATED GLASS

Laminated glass consists of two or more plies of glass interleaved with clear or tinted polyvinyl butyl (PF). The application of heat and pressure bonds the glass and plastic interlayer into one unit. When laminated glass is fractured, the particles of glass tend to adhere to the plastic, affording protection against flying or falling particles. Some combinations of glass and plastic thicknesses do qualify as safety glazing materials under the criteria of ANSI Z97.1-1984 and CPSC 16 CFR 1201.

From a windload standpoint, laminated glass is generally Considered to be approximately 60% as strong as annealed glass of the same total thickness. Recent studies, as yet unpublished, indicate that laminated glass may be virtually as strong as monolithic glass of the same thickness at normal temperatures, when subjected to wind loads. Additional research is in progress.

Laminates of glass and polycarbonates are available for special uses involving resistance to impacts of large magnitude. Laminated glass can be made in many combinations of clear, tinted or reflective glass, annealed, heat strengthened or tempered, with PF ranging from .015" to .090" or more, dependent upon desired usage. Some of the most common architectural uses are for safety glazing, burglar resistance, bullet resistance, sound transmission reduction, sloped glazing and space enclosures.

A relatively new process, called resin laminating, is finding use in the laminating of curved glass and other special short-run applications. The process requires that the two lites of glass be spaced apart the desired dimension, such as 0.030 or 0.060, and the perimeter dammed on three sides. The assembly is stood vertically and a liquid mixture of chemicals is poured into the space between the lites and allowed to cure at room temperature from two to ten hours before it is ready for use.

MIRRORS

Most mirrors are manufactured by the wet chemical deposition method, although a few, for specialized use, are made by vacuum deposition. This processes are described under the Reflective Glass Section. There is a wide range of thicknesses, qualities and sizes available with annealed glass.

Safety mirrors are available to meet various laws and building codes. A mirror made from tempered glass will have the inherent distortion from the tempering process hence cannot have the same quality in reflection as laminated one made from mirror quality annealed float glass.

Transparent, or two-way mirrors, are designed to allow vision through from one direction while presenting a mirror appearance from the opposite side. Their major application is to permit undetected observation for study or surveillance in places such as prisons, gambling casinos and psychiatric treatment centers. A difference in lighting level is necessary; in the room to be studied the lighting level should be at least five times greater than the lighting level in the observation room; ten times greater is even more effective. Two way mirrors are not intended for use in exterior walls.

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3M™ Window Film
Thermal Stress

- All glass absorbs energy when exposed to solar radiation
- Tinted glass absorbs more energy than clear glass
- Occurs when there is a temperature differential between center of glass and shaded edges
- The ability of the glass not to break is determined by its edge strength
- Always starts at the edge of the glass at least 2 inches from a corner
- The first 0.5”-1” of the crack will begin perpendicular to the edge of the glass

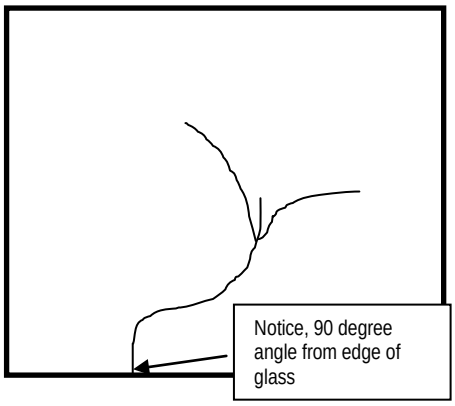
GLASS EDGE STRENGTH

1. Glass is made to withstand from between 3000 to 5000 psi (210 to 350 kg/cm) of edge stress
2. When edge stress exceeds edge strength, breakage occurs
3. Edge strength depends on glass size, thickness, how it is cut, and treatment of edge by glazier
4. A straight clean edge is the strongest
5. Damaged edges can reduce edge strength by up to 50%

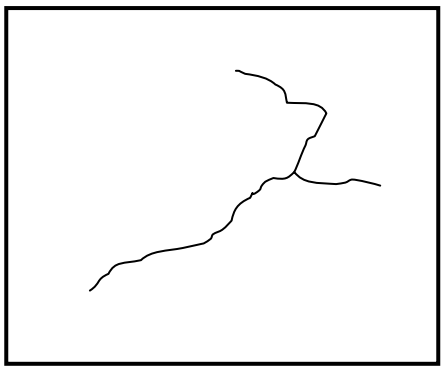
Will 3M™ Sun Control Window Film Break My Glass?

State the Facts when Answering – see FAQs

1. Partial shading patterns from overhangs or extensions
2. Tight fitting drapes or blinds
3. Painted signs, decals or labels on glass
4. Heating and cooling vents directed at glass



Typical Thermal Stress Crack



Typical Impact Crack

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3M™ Window Film
Glass Checklist

Situations where glass checklist is required (All Window Films)

1. Single pane glass larger than 100 square feet (9.3 square meters).
2. Double pane glass larger than 40 square feet (3.7 square meters).
3. Clear glass thicker than 3/8 inch (9.5mm).
4. Tinted glass thicker than 1/4 inch (6mm).
5. Architectural shading from exterior overhangs, extensions, columns, pillars, etc.
6. Window framing systems of concrete, solid aluminum or solid steel.
7. Glass where sealant or glazing compound has hardened.
8. Buildings with more than 1% previous glass breakage or problems over the last two (2) years.
9. Reflective glass.
10. Laminated glass in single pane or double pane.
11. Window where frame is damaged.
12. Architecturally odd-shaped windows (half moons, cathedral, etc.) larger than 20 square feet.

Situations where glass checklist is required (specific films)

1. Prestige 40 on double pane glass where blinds or drapes are present
2. Neutral 20 on double pane glass
3. Color Stable 5 or Color Stable 20 on single pane glass
4. Black Chrome 10 or Black Chrome 20 on single pane glass
5. Black Chrome 35 or Black Chrome 40 on double pane glass
6. FX-ST 5 on single or double pane glass
7. FX-ST 20 or FX-ST 35 on double pane glass
8. FX-HP 5 or FX-HP20 on single pane glass
9. FX-HP 30 or FX-HP35 on double pane glass

No Coverage - Do Not Submit Glass Checklist Form for the Following - No Glass Breakage Warranty (All Films)

1. Wired, textured or patterned glass.
2. Interior application: triple pane glass or double pane glass in conjunction with a suspended film.
3. Partial applications of film to glass.
4. Applications of more than one tinted or reflective film to glass.
5. Visibly brittle, chipped, cracked or otherwise damaged glass.
6. Glass blocks.

No Coverage - Do Not Submit Glass Checklist Form for the Following - No Glass Breakage Warranty (Specific Films)

1. Color Stable 5, Color Stable 20, Black Chrome 10, Black Chrome 20, FX-HP 5, FX-HP20 on double pane glass*
   *Warranty coverage is available for tempered glass, glass checklist required

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3M™ Window Film
Glass Checklist

3M Glass Breakage Warranty

- Does Not apply to restricted film/glass combinations or situations without 3M's prior approval.
- Prior approval requires completing a Glass Checklist on the 3M eWarranty System.
- 3M will calculate expected edge stress and determine if application is recommended and return confirmation via e-mail, fax, or mail.
- Copy of 3M prior approval must be attached to warranty.
- Only applicable in continental U.S.
- Note that the warranty, if approved by 3M, covers glass failure caused only by thermal stress.

Note: Dealer failure to obtain 3M's prior approval will result in no glass breakage warranty

Instructions for Completing Glass Checklist

Customer-Dealer Information Section

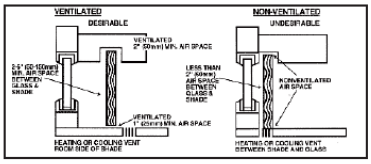
Complete the contact information for both the customer and dealer. This information is used on the report cover, and is helpful if any questions about the project are encountered while creating the report.

Building Information Section

1. Indicate the appropriate glass type.
2. If the window is single pane indicate if the glass is Annealed, Laminated, or Tempered (you must choose one).
3. If the window is double pane indicate if the glass is Annealed, Laminated, or Tempered for the interior and the exterior panes.
4. Enter the glass height and width in inches (mm).
5. Select the proposed 3M Sun Control Window Film™ Window Film type(s).
6. If the window is single pane provide the glass thickness in inches (mm).
7. If the window is double pane provide the glass thickness in inches (mm) for both the interior pane and the exterior pane.
8. Enter the number of windows in the building.
9. Provide the building age in years.
10. Has the building experienced glass breakage in the past (check either yes or no)? If there has been glass breakage enter the percent of the windows that break each year.

Indoor Shading Section

1. Indicate the type of indoor shading.
2. If drapes are used specify the color and the weave type.
3. If blinds are used specify the color.
4. Determine if the indoor shading is ventilated or non-ventilated by using the diagram below.
5. Indicate the space between the glass and the indoor shading.



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3M™ Window Film
Glass Checklist

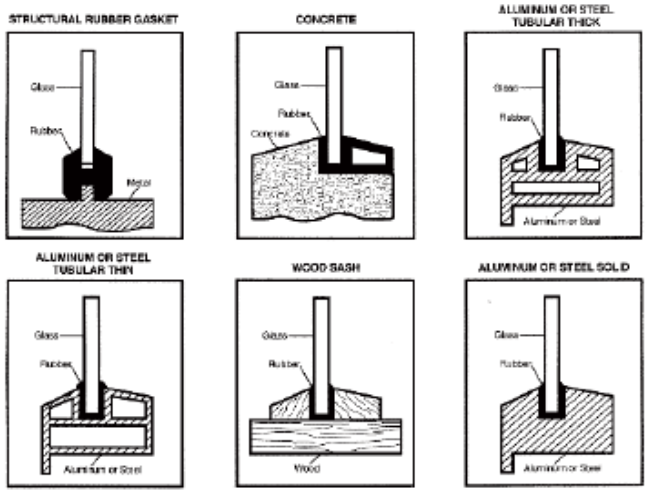
Instructions for Completing Glass Checklist, Continued

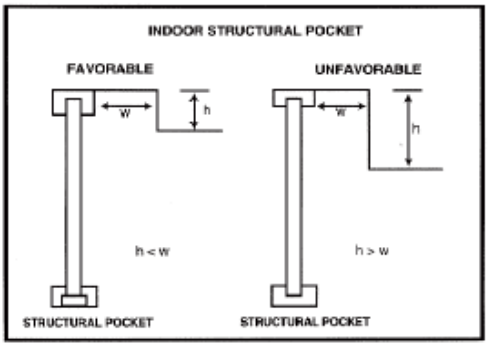
Outdoor Shading Section

1. Select the **outdoor shading pattern** that indicates the most common shading pattern of the glass in this building.
2. If there is no shading pattern check the **None** box

Window Framing Section

1. Select the **framing system** used in the window from the choices shown below.
2. Specify the **sealant type** (i.e., rubber, neoprene, etc.).
3. Indicate the **condition of the sealant**.
4. Indicate the **condition of the frame**.
5. Indicate the **outdoor glazing stop color**.
6. Determine if there is an **indoor structural** pocket present (see drawing below).





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3M™ Window Film
Glass Checklist

Instructions for Completing Glass Checklist, Continued

Window Type Section

1. If the window is **not square or rectangular** select the shape that most closely resembles the actual shape of the window.
2. If the window is square or rectangular check NONE.
3. Is the window area **greater than 20 square feet** (1,86 square meters)? Check the appropriate box.

Heating Register Location Section

1. Determine the location of the heating/cooling register and its position in relationship to the glass and any **indoor shading device**.
2. Check one of the four choices.

Other Considerations Section

1. The **Design Winter Temperature** is the lowest temperature expected at the building location. Select the proper temperature range from the three choices.
2. Select the appropriate **altitude** (above sea level) for the building.
3. An **adjacent reflecting surface** could be another building, a body of water, a hillside, etc. Indicate the color of this surface, if present.

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3M™ Window Film
Glass Checklist

Expected Edge Stress Report

What Information Is Contained On The Expected Edge Stress Report?

The Report is divided into four sections:

1. General Information Section:
   a. Request Number and Date of Report
   b. Customer and Dealer Information
   c. General Glass Information Including:
      1. Glass type
      2. Typical glass size
      3. Glass edge area per window
      4. Total number of windows
   d. Proposed 3M Sun Control Window Film type

2. Installation Conditions Section:
   a. General Building Conditions
   b. Specific Description of Building Condition
   c. Thermal Stress Factors for these Specific Building Conditions

3. Expected Edge Stress Section:
   Specific Expected Edge Stress Calculation for the indicated 3M Sun Control Window Film

4. Acceptable Maximum Stress Section:
   a. The Acceptable Maximum Stress for this situation
   b. 3M™'s Recommendation: Accepted or Rejected

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3M™ Window Film
Using E-Film to Model Energy Savings

3M, partnering with the IWFA, launched EFilm to replace the Demand Analyzer simulation program.

Why switch from Demand Analyzer to EFilm?

Demand Analyzer runs off of the DOE-2 based algorithm. Demand Analyzer is a graphical interface to the DOE-2 math formula. As opposed to plugging in variables in a math formula, Demand Analyzer allows you to click on an input, such as the city and state, and then Demand Analyzer fills in hundreds of variables for that city and state into the math formula. eQuest is another well known energy simulation program that uses the DOE-2 algorithm. The EFilm program runs off of the Energy Plus algorithm. The US Department of Energy used to support the DOE-2 algorithm, but is now recommending the use of Energy Plus, which was the main reason behind developing the new program.

Another reason that 3M is moving to the EFilm program is that EFilm will be continually supported and will have regular upgrades as newer capabilities are created. Other important additional features of EFilm are:

1. Ability to model different building shapes
2. Ability to model skylights
3. Additional HVAC systems
4. Additional weather files
5. Calculation of carbon emission reduction
6. Scheduling capabilities
7. Daylighting calculations
8. Additional Insulation types
9. Seasonal Rate utility charges
10. Thermal comfort indices
11. More professional looking report, including many graph types
12. And more to be added in coming versions

How to obtain a copy of the program

Before downloading this newest version, make sure to uninstall any old copies of EFilm. In Windows 7 you can uninstall the program by going to Start->Programs->EFilm->Uninstall

The program can be downloaded from the following location:

http://efilm.iwfa.com/3m/EfilmDownload.aspx

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3M™ Window Film
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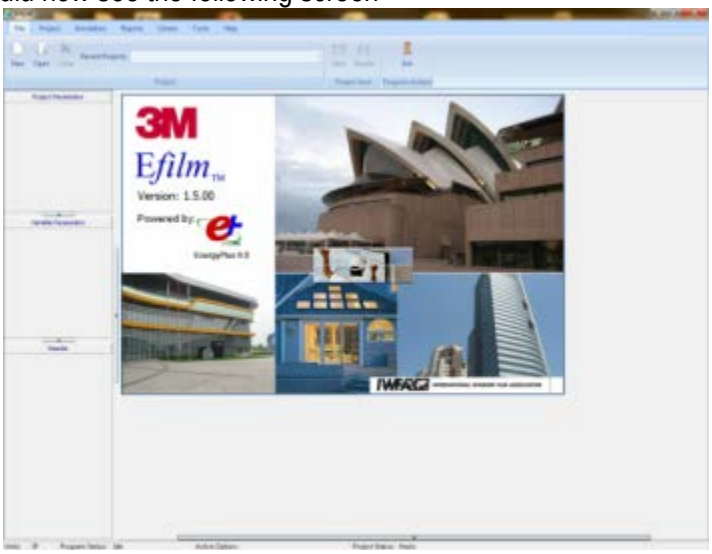
Choose EFilm installer, the complete version. The update will work from this point forward, however, many of the oldest versions of EFilm may not upgrade fully, which is why it is best to start fresh.

After you download the program you need to take the following steps:

1) Send an email to elaskeland@mmm.com with the following information:
    a. Your name
    b. Your company name
    c. City, State, and Country
    d. The email MUST be sent from the email address that you will use
2) You will not be able to use the program until, Eric Askeland updates your access in the database, once your access has been granted, complete the following steps. Technical Service will respond to you with a video that teaches you how to use EFilm, as well as the film library that you will need to load into your program.
    a. Save the file labeled 3MFilmLibrary3_11_2011.lib to your C:/ Drive (The file name may change slightly as the file is updated with new films.
3) Right Click on the EFilm program and select “Run as Administrator”
4) Enter your name (first and last)
5) Click Get Key
6) Type in the SAME EMAIL you sent for registration
7) You will be sent a user name and license key to your email address
8) Go back to EFilm and choose Enter Key, and then copy and paste the user name and password into EFilm
9) The first time you use EFilm it will ask you to enter some company information, input all of your information accurately, as this information will be displayed on the final reports you hand to customers
10) You should now see the following screen



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11) Choose Library, and then in the new box that pops up, click Library again
12) In the upper right, click Browse, and then go to where you saved the .lib file and choose that file, then click Open, then click Ok
13) Click Reports and then Report Options
14) Click Select All, and then click Select Header and Footer
15) Here you can choose to insert your company logo, or any additional information that you would like to have included in the report. (The additional information needs to be saved in .bmp format in order to be used as a header or a footer. The easiest way to change something to a .bmp format is to copy and paste the verbage, or pictures into Microsoft Paint, and then choose save.)
16) After you have made the necessary changes click OK and Close to get back to the main screen
17) Click help, and then Manual
18) Print the manual and place in a 3-ring binder for reference and training on the capabilities of the program. It is highly recommended to, at a minimum, skim through the manual, as most of the inputs and variables in the program are defined here.
19) You are now ready to use the program. All of the above steps Do Not need to be repeated, and will be saved as default settings each time you open the program
20) Lastly, you will find that there are some variables that you cannot change in the program. Many of the inputs have been locked, simply to make running the simulation program easier on a local level. If a project requires some of the inputs that you are not able to change to be edited, contact your local distributor to make the changes

Getting Started

Start by watching the 3M training video on how to use EFilm. For 3M employees this video can be found on our window film sharepoint site, and for external customers, this video can be obtained by contacting your local distributor.

Upon opening the program, choose File, new, give the project a name, and then choose create. In the "Project Parameters" box choose "Project Information" and then begin inputting data. After you finish each page choose "Apply" and then "Next". After you have input all of the values in the "Project Parameters" box, go down and choose "Base Case" under the "Variable Parameters" box, and input the relevant fenestration data. You have now created the base building. In order to create the filmed building, go to the top ribbon toolbar and choose "Project -> Add Option". Give the option a name, such as 3M Night Vision 25, and click create. Go into Option 1, in the "Variable Parameters" box and change the project cost and glass type. Then go to the ribbon toolbar and choose "Simulation-> Multiple Projects Simulation". Simulate the base building and the filmed option, and then choose "Reports->Create Report". This will get you started in learning to use the program. For more detailed instructions consult the EFilm manual. Note the simulation period for this program will take a longer amount of time then Demand Analyzer.

For immediate questions or concerns please refer to the EFilm manual. If you cannot find the answer to your question in the EFilm manual contact your local distributor or territory manager.

3M supports utilizing the latest and most accurate energy savings simulation technologies, which is why we have partnered in the development of an interface to the US DOE recommended energy simulation engine Energy Plus. This program will enable us to more accurately model unique base buildings, and more unique situations. With this added capability we bring further excellence, credibility, and expertise to you our valued 3M partners.

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3M™ Window Film
Installation

Film-to-Glass Recommendation Table

The following table is meant to be used as a guide to provide for improved installation quality and minimal confusion. We have seen that installing a film designed for flat glass application onto a vehicle can result in serious issues at times. Installing automotive films onto flat glass can cause problems as well.

Recommended (R)
Non Standard Application. Specifications may not meet customer requirements. (NSA)
Not Recommended. (NR)

Products	Automotive Category	Flat Glass Category		
	Automotive General Purpose	Commercial (Internal)	Residential (Internal)	All External Applications
3M™ Safety & Security Window Films (1)				
All interior safety films	NSA	R	R	NR
Exterior safety films	NSA	R	R	R
3M™ Automotive Window Films				
Crystalline Series	R	NR	NR	NR
Color Stable Series (3,4,5)	R	NSA	NSA	NR
FX XT Series (4)	R	NR	NR	NR
FX XT HP Series (4)	R	NR	NR	NR
FX XT 70	R	NR	NR	NR
Black Chrome Series (4)	R	NSA	NSA	NR
SAS Series	R	NR	NR	NR
Flat Glass Films				
Prestige Series	NR	R	R	NR
Ceramic Series	NR	R	R	NR
Night Vision Series	NR	R	R	NR
Traditional Series	NR	R	R	NR
External Series				
Exterior Prestige 90 (2)	NR	NSA	NSA	R
Exterior Prestige 40 and 70	NR	NR	NR	R
Exterior Metallized Film Series	NR	NR	NR	R

Footnotes:
1 – Safety films are “Non Standard” or “Not Recommended” in Automotive because of their thicker layer of adhesive..
2- Exterior Prestige 90 is the ONLY exterior film that can be applied on the interior. There is no color in the hardcoat or the adhesive, so there is no risk of increased absorption by installing on the interior. Exterior PR40 and Exterior PR70 CANNOT be installed on the interior due to glass breakage risk
3 – Color Stable used in Flat Glass is a “Non Standard Application” because of thermal stress factors.
4 – Black Automotive films have more color change than Flat Glass films and are therefore “Non Standard” or “Not Recommended” for Flat Glass.
5 – Appearance specifications and product design make Windshields a “Non Standard” or “Not Recommended” application.

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3M™ Window Film

Installation

Flat Glass

Tools and Equipment: Installation tools can typically be purchased through your distributor

Authorized 3M Sun Control WF Dealer

Film handler
Replacement blades for film handler
Three-gallon (11 liter) plastic PRESSURE spray tank - 8' - 10' (2-3m) plastic hose
12" (30.5cm) Window cleaning squeegee with replacement rubbers
5” (13 cm) Blue Max Film application squeegee
4" (10 cm) Window scraper with replacement blades
Five-way tool
Olfa knives with stainless steel replacement break-away blades
Mild Baby Shampoo
Blade Eater

Miscellaneous Hardware & Equipment

Available locally

15' (5 m) or 25' (8 m) Tape Measure
Drop cloths (absorbent)
Lint-free towels
White 3M ScotchBrite™ scrubber
Vacuum cleaner (aqua-vac)
Small paint brushes (for edge sealer)
3M™ Brand masking tape
Edge Sealer - 3M™ Clear Auto Sealer - Part #08551 - for exterior and interior
Step ladders and extension ladders
Scaffolding or access equipment as required

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3M™ Window Film
Installation

Tool and Equipment Inspection

Inspect Before Leaving For Application Site

1. Film Dispenser
   a. New sharp blades
   b. Alignment of horizontal cutter
   c. Spare blades
   d. Clamp bar - surface clean and positive grip
2. Plastic Pressure Spray Tank
   a. No Leaks
   b. Flush out before filling
3. Squeegees
   a. Clean, Straight, Flat and Sharp
   b. Blade edge - replace if worn or nicked
4. Application Squeegee Repair
   a. Rub across edge with 400 or 600 grit 3M Wetordry™ brand sandpaper
   b. Maintain good square edge
   c. If nicks and chips are still present, use 200 or 300 grit 3M Wetordry™ brand sandpaper. Go back and finish off with 400 or 600 grit 3M Wetordry™ brand sandpaper.
5. Knives
   a. Use break-away blades
   b. Use new tip after 3 cuts
   c. Use stainless steel blades

Film Inspection

Inspect Before Leaving For Application Site

1. Correct Film
2. Correct Sizes
3. Free of Visual Defects
   a. Edge damage
   b. Buckles
   c. Wrinkles
4. Sufficient amount of film and proper run number

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3M™ Window Film
Installation – Flat Glass Window Films

Note on Installation of Safety Films
3M™ Safety & Security films install differently than the standard Sun Control or Architectural films. Because they are generally thicker, their proper installation requires added squeegee pressure and special technique to ensure maximum water removal. In addition, some water may remain behind, causing a haze and blotchy appearance. This is completely normal and may take several weeks to dry. For the best results, follow the techniques outlined below.

3M™ Ultra Series Safety & Security films feature a unique microlayer construction that makes them more flexible than films of similar thickness. This allows for easier application. When cutting 3M™ Ultra Series films, it is required that the film be cut all the way through -- do not try to tear at an edge. It may pull the film off the glass requiring additional spray and reapplication.

Window Preparation
Whenever possible, the customer should provide clear access to window
Protect floor, carpet, window ledge, wall, etc., with suitable absorbent material such as a drop cloth. It is not recommended to use plastic sheeting on the floor as it may become too slippery.
If possible, turn off heating/AC and ventilation ducts to reduce dirt and dust in the air or on the glass.
Set up film dispenser (or box) for cutting.
Have tools and supplies as close to the window as possible. A tool belt for the applicators is recommended.

Clean Glass and Frame
Wipe down window frame with damp cloth or sponge.
If window putty or seal is old or cracked, tape or seal prior to washing glass.
Wash window using pressure spray tank and slip solution.
Thoroughly flush edges.
Scrape glass using window scraper and proper blades. If necessary, use White 3M ScotchBrite™ scrubber to remove additional residue.
Thoroughly rinse glass from top to bottom with pressure spray tank.
Squeegee entire glass surface.
Dry glass edge and window frame.

Film Application
Lightly spray glass with slip solution.
Cut film 1" (25 mm) wider and longer than glass surface
Lay film on glass with liner or adhesive side toward you.
Remove liner. In dry conditions, to minimize dust, you may want to spray the liner with some slip solution before removing.

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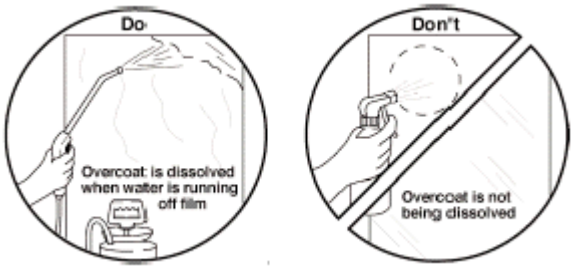
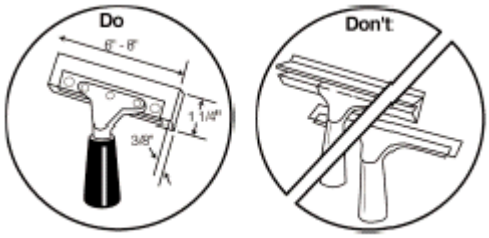
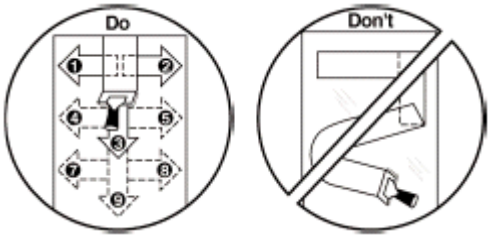
- IMPORTANT: If film contains overcoat, thoroughly wash off overcoat using slip solution in a plastic pressure spray tank. Apply enough water solution so that it is running off the bottom of the film. Refer to guidelines on Proper Overcoat Removal.



- Wash fingers with slip solution.
- Turn film around and apply to glass.
- Position right side and top, leaving 1/8" (3 mm) border between the edges of the film and frame
- If window is not square; all edges might need trimming.
- Squeegee film to glass using proper squeegee. The proper squeegee is no more than 6 inches wide. The squeegee should be straight, sharp, flat and free of cuts nicks or other defects. The “Blue Max” is recommended. If the blade is too hard or soft, water removal will be difficult.



- Lightly spray film surface with positioning solution.
- Use proper squeegee pattern and use both hands to apply firm pressure:



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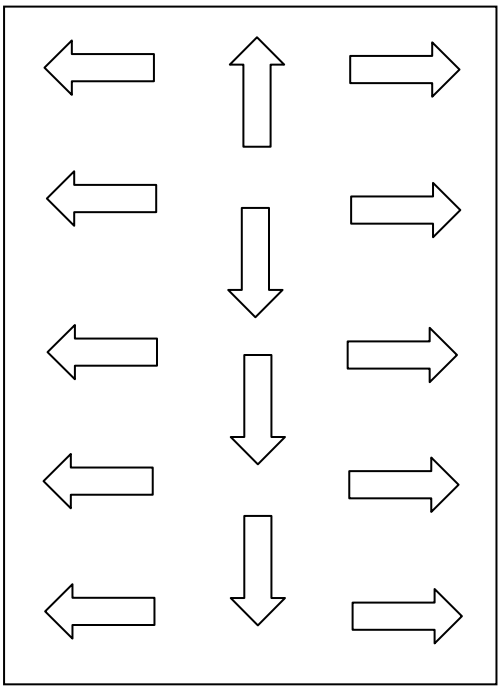
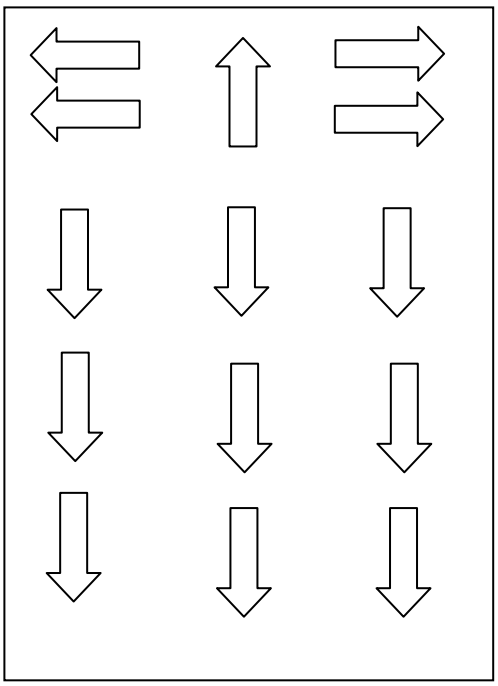
- Always keep squeegee blade lubricated with positioning solution.
- The first squeegee pass is the most critical for removing water to achieve a high quality installation. Be sure to apply firm pressure using both hands and 50% overlap on the first pass.
- Thicker films compound the difficulty of removing the maximum amount of water on the first pass. Illustrated below are two squeegee techniques. The technique on the left is acceptable for thinner films (less than 6 mils thick). For thicker films, it is recommened to use the technique illustrated on the right:



Thin Films Technique



Thick Films Technique

- The Thick Films Technique will produce great results for thin films but the Thin Films Technique may not produce acceptable results for thicker films.
- Allowing gravity to work with you to remove the water helps achieve a quality installation with minimal effort.
- Squeegeeing more than once should not be necessary if properly done the first time
- Trim film to size using a trimming guide and OLFA knife to within 1/8" (3 mm) of window frame.
- Always use new blade tip after a maximum of 3 cuts for thin films and after every cut for security films.
- Re-lubricate with slip solution and re-squeegee (using squeegee and squeegee pattern mentioned above) until all water is removed.
- Bump film edge with absorbent lint-free towel wrapped around edge of five-way tool.
- Wipe frame edge dry.

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3M™ Window Film
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Champagne Bubble Reduction and Proper Overcoat Removal

3M™ Ultra Series Safety and Security Window Films as well as a few 3M Sun Control Window Films are made with a special adhesive "overcoat" to facilitate removal of the liner and to allow for easier repositioning of the film on glass. While the overcoat makes handling of the film easier, it is critical that it be washed off properly to ensure a quality film installation with minimal defects. Residual overcoat may lead to "champagne" bubbles, which may not be readily visible immediately after the film installation.

The following 3M™ Window Films contain an adhesive overcoat:

- Low E 35 (LE35)
- Silver 35 & Nickel 50
- Ultra Prestige PR S50 & Ultra Prestige PR S70
- Ultra Night Vision S25
- Ultra Silver S20
- Ultra Neutral S35 & Ultra Neutral S50

Properties of the Overcoat: The overcoat turns into a gelatin-like substance when wet. It is soluble in cold water but insoluble in hot water (>120°F). Due to its unique temperature-dependent solubility properties, it is extremely important that as much overcoat is removed as possible before applying the film to glass – especially on glass that is already hot during the film installation or on glass that is likely to get hot before the film has completely dried. Residual overcoat that is trapped in a thin layer of hot water between the film and glass may begin to solidify, which could lead to an irreversible "champagne bubble" defect that could develop until the film has completely dried (usually within 7 days).

Overcoat Removal Instructions: The film adhesive must be washed with water / slip solution. Simply wetting the film with slip solution is not enough to wash off the overcoat. Begin washing the adhesive at the top of the film, allowing a front of water to gravitate down the film while slowly washing the rest of the film below. The slip solution should be running off the film (along with the overcoat) when washed properly.

CAUTION using 'Reverse Roll' Techniques: Reverse rolling is a convenient method of applying film on large windows. This method involves spraying slip solution onto the glass and unwinding the roll along the glass. Spraying the glass only is NOT a sufficient means of overcoat removal. If using a reverse roll technique to separate film from liner, it is necessary to remove the film from the glass to thoroughly wash off the overcoat as described above before repositioning the film for final application.

Employing the following general best installation practices will also help reduce the chance of residual overcoat induced champagne bubble formation:

- Avoid working under conditions when the glass is hot (glass surfaces that are or likely to be above 120°F within 72 hours)
- Use a stiff squeegee blade that is sharp, straight, and flat; and no wider than 6 inches
- Use just enough soap in the slip solution to allow for easy repositioning of the film on the glass – no more, less.
- Overlap squeegee strokes by at least 1/3, angling the squeegee towards the wet areas of the film. Forcing water through dry areas of the film can also lead to champagne bubbles. Squeegeeing areas more than once should not be necessary when employing the proper pressure and squeegee tools

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3M™ Window Film
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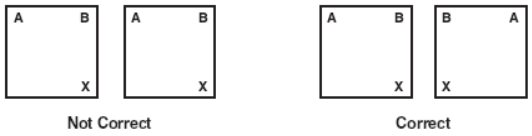
Splicing

- WHEN SPLICING ALWAYS USE THE SAME ROLL OF FILM FOR THE ENTIRE WINDOW. Extremely minor differences in visual aesthetics, which may be evident from roll to roll, will only be seen when a window film is spliced. These differences would not be visible when the films are applied to different windows
- Position and direction of splice must be determined by salesperson and customer prior to film installation.
- Leave instructions with customer that window washers should be aware of splice and squeegee window from direction of film that is on top.
- Always match factory edge to factory edge - Mark edge with masking tape.
- To reduce the risk of splice joint gap, squeegee parallel to the film edges to be joined



Overlap Splice

1. Overlap splice pieces about 1" (25 mm) and draw back to 1/8" (3 mm)
   a. Horizontal splice - upper piece overlapping lower
   b. Vertical - Left-hand piece over right-hand piece
2. Slowly squeegee parallel to overlap splice - lubricate film as required
3. Squeegee out maximum amount of water
4. Overlap splice is preferred for Safety and Security Window Films (overlap splice must be 1/8" - 1/4" (3-6 mm)

Butt Splice / Cut Through Splice

1. Overlap film pieces 1" (25 mm)
2. With new sharp blade and a straight edge, cut through both pieces in exact center of overlap
   NOTE: Use a new blade for each and every splice cut
3. Remove small piece from top, lift corner of bottom panel and remove lower smaller piece (spray water on splice during this process)
4. Slowly squeegee parallel to splice - lubricate as required
5. Squeegee out maximum amount of water

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Edge Sealing

Why Edge Seal?

1. Protect edges from moisture
2. Prevent corrosion
3. Protect during washing
4. Helps protect against vandalism

IMPORTANT NOTES:

- Edge sealing is REQUIRED for ALL metalized exterior film applications or no warranty claim will be accepted.
- Edge sealing is not required for Exterior Prestige or Safety Exterior unless any of the following conditions apply:
  - Edge sealing is REQUIRED for ALL exterior film applications – vertical, sloped, or horizontal glazing - where water, snow or ice can accumulate, or no warranty claim will be accepted. (Example: non-vertical glass where there is no drainage around the bottom edge of frame).

How to Edge Seal

1. Use 3M Clear Auto Sealer (part #08551). Available through automotive paint and body equipment suppliers
2. Surfaces must be clean and dry
3. Apply sealant with small foam or bristled paint brush (recommended ¼" brush width) or cotton swab
4. Apply sealant with minimum overlap of 1/4" on film surface and 1/4" on glass surface
5. Avoid sealant running down surface of film

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Weather Guidelines – Interior Film

The main concern with installing film at temperatures below freezing would be that any water left behind during installation would freeze and cause a visible defect in the film. Thus the best method for reducing any potential problems would be to take extra care to remove all excess water during installation. The only way that the water could potentially freeze would be if the temperature of the interior pane of glass dropped below 32 ˚F. Below are a few recommendations to look for when installing in cold temperatures. As a general rule these guidelines would be recommended any time temperatures are expected to be under 0 ˚F for double pane glass or under 32 ˚F for single pane glass, within 72 hours of the installation period.

1. Check the temperature of the interior pane of glass, with an understanding that the temperature of the glass will drop significantly at night. If the temperature of the interior pane is less than 32 ˚F do not install film.
2. Spray the glass with film mounting solution, if the mounting solution freezes do not install film.
3. Use a temperature gun to determine the temperature of the frame of the window right next to the glass. Water left around the edges of the glass could freeze due to the frame
4. Check to see if heating vents are directed at the glass and will hold that glass at a warmer temperature, often allowing film installation at significantly lower outside temperatures.
5. Determine what temperature the building is kept at during the night. Often unoccupied spaces, or spaces being renovated will be kept at much lower temperature, as are some buildings that utilize temperature setbacks at night.

In general, there are very few days that would prohibit film installation in the US climate. The interior temperature of the building will typically hold the interior glass temperature above 32 ˚F. The above are situations to be aware of, as well as suggestions to minimize the risk of installing film in temperatures that are too low.

Weather Guidelines – Exterior Film

1. Do not install film during precipitation, as this will cause debris to run off the building and get behind the film
2. Do not install film if the exterior temperature will drop below 32F in the next 15 days
3. Do not install film if the temperature of the exterior glass exceeds 120F or is too hot to touch, in some cases you may need to ensure that you are installing film on the side of the building that is not getting direct sunlight during the time of the installation
4. Check for windy conditions

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3M™ Window Film
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IWFA Visual Quality Standard

IWFA INTERNATIONAL® WINDOW FILM ASSOCIATION — VISUAL QUALITY STANDARD FOR APPLIED WINDOW FILM

Visual Quality Standard for Applied Window Film

As adopted by the IWFA May 15, 1999*

1. Installed film on flat glass surfaces is not expected to have the same level of visual quality as glass. The following criteria apply to the installed film only and not to any defect inherent in the glass.
2. Installed film has a discrete time for full adhesion to be effected since installation utilizes a detergent solution in the water to float the film onto the glass: the excess water is squeegeed out, but inevitably residual water will remain between the film and glass. The time to achieve full adhesion is often referred to as "the adhesive cure time". Adhesion will be increasing from a lower value during this time. Visual and adhesive cure time is related to thickness of the film and various metallic coating on the film. Typical visual cure times may be extended or shortened according to climatic conditions.
3. Inspection for optical quality can be made before full visual cure is attained. Table 1 provides a guide for typical visual cure times. It should be noted that effects during cure, such as water bubbles, water distortion, and water haze are not to be regarded as defects.
4. The glass with applied film shall be viewed at right angles to the glass from the room side, at a distance of not less than 6 feet (2 meters). Viewing shall be carried out in natural daylight, not in direct sunlight, and shall assess the normal vision area with the exception of a 2 inch (50mm) wide band around the perimeter of the unit.
5. The installation shall be deemed acceptable if all of the following are unobtrusive (effects during visual cure should be disregarded): Dirt Particles, Hair and Fibers, Adhesive Gels, Fingerprints, Air Bubbles, Water Haze, Scores and Scratches, Film Distortion, Creases, Edge Lift, Nicks and Tears.

   Inspection may by made within 1 day of installation. Obtrusiveness of blemishes shall be judged by looking through the film installation under lighting conditions described in 4.
6. The 2 inch (50mm) wide band around the perimeter shall be assessed by a similar procedure to that in 3 and 4, but a small number of particles is considered acceptable where poor frame condition mitigates against the high quality standards normally achieved.
7. Edge gaps will normally be 1/32-1/16 inch (1-4mm). This allows for the water used in the installation to be squeegeed out. This ensures that film edges are not raised up by contact with the frame margin. Contact with the frame margin could lead to peeling of the film.
8. For thicker safety films the edge gaps will normally be 1/32-1/16 inch (1-4mm), with 1/32-1/8 inch (1-5mm) being acceptable for films of ≥ 7 mil (175μ). Combination solar control safety films will also fall within this standard.

   An edge gap of up to 1/16 inch (2mm) is recommended, especially for darker (tinted, metallized, tinted/metallized, and sputtered) films, to minimize the light line around the edge of the installed film.
9. Splicing of films is necessary when larger panels of glass are treated, where both length and width of the glass exceed the maximum width of film. The splice line itself should not be viewed as a defect. This line should be straight and should be parallel to one edge of the frame margin. The two pieces of film may be butt jointed. The maximum gap at any point in the splice line should be 1/64 inch (1mm). Film may be overlapped, spliced or butt jointed.
10. Certain films with special high performance coating may have lengthened cure times. Consult the manufacturer for cure times of these films.

Table 1 - Typical Cure Times

Film thickness in mils	Film thickness in microns(μ)	Typical Cure Time (days)
Up to 4	Up to 100	30
4 to 8	100 to 200	60
8 to 12	200 to 300	100
Over 12 but not more than 17	Over 300 but not more than 425	140

*Special adaptation of information received from the Glass and Glazing Federation; reproduced with their permission.

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Important:
The information provided in this report is believed to be reliable; however, due to the wide variety of intervening factors, 3M does not warrant that the results will necessarily be obtained. All details concerning product specifications and terms of sale are available from 3M.

3M™ Window Film

Important Details about your Installation of 3M™ Sun Control Window Film

Dear Customer:

Congratulations! You have just purchased a superior sun control film. 3M has devoted 30 years to the development and improvement of 3M™ Sun Control Window Film so that today you may enjoy the sun without experiencing the full effects of its harmful rays.

As with all products containing an adhesive system, a drying time is necessary to achieve the proper bond to the window. During this process, some changes may be observed. So that you will understand these differences, we would like to note some of them for you. They are normal and should be expected. Listed below, by way of recap, are the points covered by your Authorized Dealer.

- Drying time will be approximately 30 days. Please do not wash your windows during this period.
- Any haziness you may see is water under the film. You will see less and less of this as the days pass.
- A milky appearance might be experienced, but it too disappears during the drying period.
- All water bubbles will dry out, but a few small particles or points may be apparent when dry. These points, generally seen from the outside, are very tiny and are inherent in the use of a pressure sensitive adhesive system. An adhesive of this type is used because it is the only one that will withstand high humidity, driving rains and window condensation. You will normally see these particles only if you get quite close to the glass, which is something we ordinarily do not do. They will not affect the films performance.

The 1/8" (3 mm) border you notice is a requirement of the application according to 3M.

- Cleaning should be done using normal household window cleaners* or any non-abrasive window cleaning solution and wiping with a soft towel or squeegee. Paper towels or natural sponges should not be used.

NOTE: Sometimes what seems to be a defect in the film is, in fact, an imperfection in the glass. It is quite natural that one should look closely at a new purchase, but at times we observe things that were always there but never noticed. A good rule to follow is to look at the installation from six feet away. This is the manner in which we normally look through a window and the way in which you should observe your 3M™ Sun Control Window Film — looking through it, not at it.

We and 3M hope you will enjoy your installation. With proper care, we know you will receive many years of benefit from its presence on your windows.

Very truly yours,

_____

Authorized Dealer/Applicator

*See warranty for cleaning instructions.

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3M™ Window Film
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Care and Cleaning Instructions for 3M Films

1. CARE MUST TAKEN NOT TO SCRATCH THE FILM, DO NOT USE BRISTLE BRUSHES OR ABRASIVE CLEANING MATERIALS
2. Household window cleaning solutions, such as Windex, are recommended
3. A soft cloth or clean synthetic sponge is recommended for washing. Do not use the same towel or sponge for wiping sills or frames. Paper towels or newspapers not recommended
4. A soft squeegee is recommended for removal of cleaning solution from the film
5. Do not apply heavy pressure in any cleaning operation
6. TIPS:
    a. Additional caution is recommended when cleaning spliced areas. Clean in the direction of the splice
    b. Do not leave the film wet
    c. Make sure you use a different sponge, cleaning cloth and water bucket for cleaning the outside and the inside of the windows
    d. Use a little extra detergent for cleaning 3M™ Sun Control Window Film — it gives more ease to squeegeeing

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3M™ Window Film
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Film Removal

1. Lift edge and try to pull off in sheets
2. 2. If film is wider than1' to 2' (30 to 60 cm), carefully cut into 1' to 2' (30 to 60 cm)strips

OR

3. Spray solution of ammonia and water onto film
4. Apply plastic film or newspaper on film
5. After one to two hours of soaking, lift edge and pull off in sheets
6. Clean adhesive residue with scraper using solution of ammonia and water

Application Do's

1. Do apply film on clean glass
   a. Better application
   b. Use 3M™ Scotch® Magic™ mending tape to test for adhesion
2. Do use a sufficient amount of positioning solution during application
   a. Wash off overcoat
   b. Cleaner application
3. Do use plastic or stainless steel pressure spray tanks
   a. More consistent cleaner applications
4. Do use plenty of new sharp stainless steel blades during cutting and trimming
   a. Less fingers
   b. Film lays down better
   c. Won't scratch glass
5. Do apply film on entire surface of glass
   a. Partial application can cause breakage (added stress)
   b. No glass breakage warranty on partial applications
6. Do squeegee out the maximum amount of water
   a. Less drying time
   b. Better adhesion
   c. Better overall performance and visual appearance
7. Do allow 1/8" (3 mm) to 1/16" (1.5 mm) border between film and molding
   a. Water removal
   b. Reduce dirt entrapment at edge
   c. Reduce edge damage
   d. Reduce edge corrosion
8. Do apply Exterior film on clean glass
   a. Protect against elements
   b. Reduce edge corrosion
   c. No warranty if not edge sealed
9. Do use absorbent lint-free towels
   a. Cleaner application

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3M™ Window Film
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Application Don’ts

1. Don’t use too much slip/positioning solution concentrate in the mixture with water
   a. Less adhesion
   b. More fingers
2. Don’t use steel pressure spray tanks
   a. Rust between film and glass
3. Don’t use silicone polish after installation
   a. No emissivity with 3M™ Sun Control Plus Window Films
4. Don’t add alcohol or other additives to slip/positioning solutions
   a. Detackifies adhesive
   b. Adhesive failure
5. Don’t use double application of films
   a. Heat build-up - glass breakage
   b. Lack of adhesion
   c. Longer drying times
6. Don’t apply film on plastics
   a. Heat and light cause outgassing
   b. Bubbles occur
   c. Can’t remove adhesive
7. Don’t apply film to chipped, broken or damaged glass
   a. No warranty
8. Don’t apply films onto glass on restricted list without submitting Glass Breakage Checklist
   a. No warranty
9. Don’t apply film in building under construction
   a. High dust/dirt level
   b. Drying time with temperature differences

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3M™ Window Film
Installation
3M Automotive Window Films
Recommended Tools and Supplies

Having the proper tools and supplies for vehicle film applications is extremely important, not only in quality of the installation, but for productivity as well.

1. Cutting/Trimming Tool
    a. Choose the most comfortable
    b. Most widely used have replacement break-away blades
    c. Stainless blade is mandatory over standard steel
        1. Will not scratch glass if proper pressure is applied
        2. Will lose sharpness quicker, so never use same tip for more than three cuts
2. Window Cleaning Scrappers
    a. One inch (25mm) for smaller windows
    b. Four inches (100mm) for most others
3. Trimming Guides
    a. 5-Way tool (whole or cut-a-way)
    b. Triangle with hole cutting guide
4. Application Squeegees
    a. Yellow tube type (Turbo Squeegee) - most popular
    b. Hard card tool with absorbent towel - to remove maximum amount of water
5. Window Cleaning Squeegee
    a. Good for cleaning windows
    b. Not good for applying film
6. Absorbent Towels
    a. Need absorbency and lint free
7. Pressure Spray Tank and Hand Spray Bottle
    a. Always use plastic or stainless steel containers instead of galvanized steel to prevent rust from coming between film and glass
    b. Three-gallon (11 liters) pressure spray is best
        1. More volume of water
        2. More pressure to flush away dirt and dust
        3. Larger spray pattern
        4. Save time during application
        5. Less physical activity
        6. Save time refilling
    c. Three-gallon (11 liters) replacement spray nozzle
        1. Contains plastic in-line filter
        2. Best spray pattern for cleaning and film application

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   d. Install in-line filter onto hose of three-gallon (11 liters) pressure sprayer
      1. Use a clear casing to see amount of contamination from water supply
      2. Change often
   e. Do not add to water in tank. Empty tank and refill with clean water daily or more often.
8. Slip/Positioning Solution
   a. Recommend product for use in the slip solution is Mild Baby Shampoo
   b. Use of other types of detergents, especially grease cutters, may cause poor adhesion
   c. Proper slip solution ratio is 5 drops/gallon (3.8 liter)
   d. Too high a concentration level causes:
      1. Adhesive to detackify
      2. More fingers
      3. Film not to lay down properly
9. Adhesive Remover
   a. 3M™ Glass Cleaner - available through Authorized 3M™ Sun Control Window Film Distributor
   b. Use White 3M™ Scotch-brite™ pad when cleaning glass with heater lines
10. Portable Fluorescent Light
   a. Provides light to shine through glass and film when cutting patterns
   b. Cooler light:
      1. Easy on eyes
      2. Will not burn interior of vehicle
11. "Don't Roll Down Window" Notice or Stickers
   a. Place onto switches for electric windows or on roll-down window handles
   b. Reminds customers not to roll down window for 3 - 5 days

<u>Optional</u>

1. Heat Gun - for one piece (few piece) rear windows
2. Cutting Table
3. Heat Lamps
4. Isopropyl alcohol for logo removal

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Installation – 3M Automotive Window Films

Application Process

Vehicle Application Recommendations

Take the proper amount of time and care up front to maintain a high quality dirt-free application, rather than lose production time because of redo's.

1. Have tools and supplies close to vehicle - saves production time
2. Clean inside of window
   a. Scrape
   b. Rinse
   c. Squeegee
   d. Repeat 2 or 3 times or until the window is absolutely clean.
3. Clean outside of window to eliminate dust/dirt coming into contact with film
4. Cut film pattern using only a stainless steel blade
   a. Get film to conform to curvature of glass
   b. Cut away excess film
   c. Always break off blade after 3 cuts. Improperly cut edges will cause film to not lay down, or excessive fingers
5. Clean outside window again and leave a layer of water on glass to hold the film in place
6. Wet adhesive with mounting solution as liner is being pulled off
7. Using the slip/positioning solution wet the inside of the window
   REMEMBER!! The more water between the film and the glass prior to squeegeeing, the cleaner the final application will be.
8. Place the film on the inside of the vehicle window and squeegee out the maximum amount of water. To remove water from edge, use a hard card with an absorbent towel covering the squeegee blade.

HELPFUL HINTS

1. You **can't** use too much water
2. You **can** use too much slip/positioning solution
3. You **can't** use too many blades
4. You **never** use silicone near adhesives
5. Always rinse and squeegee off any window cleaning solutions or adhesive removers prior to film application
6. Always start squeegeeing from the top of a finger and squeegee completely to edge of film

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Application Process

If film will not lay down, or you are experiencing excessive fingers, possible causes are:

a. Using improper slip/positioning solution with too much solvent or alcohol
b. Slip/positioning concentration too high
c. Edge of film cut with dull blade
d. Film cut too close to edge of window
e. Non-sticky substance on glass (silicone)

7. Remove all decals

8. If too much dust/dirt is behind film and glass, possible causes are:
   a. Did not thoroughly clean the inside and/or outside of the window
   b. Not enough water was used

9. Use fluorescent light inside of vehicles when cutting pattern from outside

10. Always apply “Don’t Roll Down” stickers on roll-down windows with film

11. Apply narrow piece of masking tape over fuzzy channel material on framed side windows - reduces amount of dust/dirt on glass

12. Rinse your fingers prior to touching adhesive

13. Always apply film below rubber molding on bottom of roll-down windows

14. When relief cutting, always cut twice the length of the finger

15. Always squeegee film on the flattest area of the glass first, then work toward the sides, and then the corners

16. The 3M logos can be easily removed using isopropyl alcohol and a clean, soft cloth or towel.

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3M™ Impact Protection Profile Installation Instructions

IMPORTANT: READ INSTRUCTIONS FOR USE BEFORE OPERATING

INTENDED USE:

The 3M™ Impact Protection Profile Installation System is for installing 3M™ Impact Protection Profile (IPP). It consists of a multifunctional tool used to properly align the profile on the window and to corner cut the profile at an optimal angle for the mitering of joints. It also includes a custom sized applicator roller used to help bond the IPP adhesive to the film and frame. The system is for use only with 3M IPP BP950 and BP700. It is expected that all users will be fully trained in the proper operation of the 3M™ Impact Protection Profile Installation System. Use in any other application has not been evaluated by 3M and may lead to an unsafe condition.

SAFETY INFORMATION

Please read, understand, and follow all safety information contained in these instructions prior to the use of the 3M™ Impact Protection Profile Installation System. Retain these instructions for future reference.

Explanation of Signal Word Consequences	
⚠ **CAUTION:**	Indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate injury and/or property damage.

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Summary of device labels containing safety information
 CAUTION: SHARP BLADE

⚠CAUTION
• **To reduce the risks associated with sharp cutting blades:** - Keep fingers out of path of the cutting blade when in use. - Ensure that the Base Plate is installed prior to use. - Use care when repositioning or changing the cutting blade. - Remove blade prior to disposal of the tool. - Discard used blades in an appropriate sharps container.

⚠CAUTION
• **To reduce the risks associated with impact:** - Secure tool with safety lanyard when working at height. - Keep bystanders away from working area. - Replace springs only with Part. No. 9657K414 available from McMaster-Carr (Steel Compression Spring Zinc-Plated Music Wire, 2.50" L,.375" OD,.035" Wire) or a spring of equivalent dimensions and compressive energy.

⚠CAUTION
• **To reduce the risks associated with sharp or rough edges:** - Do not use tool if any part of it is damaged.

Project Site Considerations:

- Ensure the work area is clean, dry and free of obstacles. Film should be allowed to dry for at least 7 days before installing IPP. If residual moisture from film installation is visible near edges of film, do not apply IPP.
- Ensure that the selected size of IPP is appropriate for the project. When flexed in a symmetrical 90-degree orientation, IPP must comfortably span the existing window gasket. For BP950, maximum gasket width is 5/16”; for BP700, maximum gasket width is 3/16”.
- IPP is only suitable for metalized frame systems where there is sufficient frame surface perpendicular to the glass. Do not apply IPP on sloped frame surfaces, wood frames, or other surfaces where IPP does not fit easily.
- Conduct an adhesion test to the existing window frames. Apply a small section (3 – 5 inches) of IPP to the frame by removing the liner from one of the tape strips and affix to the frame using sufficient pressure and a roller tool. Wait a minimum of 6 hours to allow the adhesive bond to cure, and then check adhesion by peeling off the profile at 90 degrees. If IPP peels cleanly from the frame, then 3M™ Primer 94 is required. Conduct a separate adhesion test by first cleaning the frame surface with 3M™ Primer 94. When adhesive residue is left on the frame after the peel test, adhesion is satisfactory.

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3M™ Window Film

Materials:

- 3M™ Impact Protection Profile (BP950 or BP700)
- 3M™ Impact Protection Profile Installation System (Installation Tool and Roller Tool)
- Profile cutter
- 3M™ Primer 94 (low odor alternative is 3M™ Adhesion Promoter 111)
- Razor blade or utility knife
- 3M™ Citrus Base Cleaner or rubbing alcohol
- Rubber nitrile gloves
- White grease pencil

Window Prep:

- Ensure window frame and film surfaces are dry and free of dirt, debris, dust and grease. Remove any contaminants on frame surface with 3M™ Citrus Base Cleaner, rubbing alcohol, or commercial cleaning solution. Do not use soapy water to clean the frame as soap and water residue could reduce IPP bond strength.
- For difficult to remove contaminants, a plastic scraper or razor blade may be used in conjunction with 3M Citrus Based Cleaner, alcohol, or commercial cleaning solution. Consult with building owner or project manager prior – 3M does not assume liability for any damage that may be incurred during cleaning process. IPP requires a clean, dry and smooth frame surface to bond properly.
- Do not use any abrasive cleaners or tools on the film surface.
- If frame surfaces are relatively clean, 3M Primer 94 may be used as combination cleaning / priming agent. Apply a small amount of Primer 94 on a lint free towel and simply wipe onto the frame.

Film Installation:

- Follow 3M Window Film Installation Instructions.

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3M™ Window Film

IPP Tool – Components:

The IPP Tool consists of the following features (refer to Figure 1):

a. BP950 Alignment Surface – wide cavity along the side of the tool for positioning larger sized BP950 profile
b. BP700 Alignment Surface – narrow cavity along the side of the tool for positioning smaller sized BP700 profile
c. Positioning Flats – Flat sections on either side of the Alignment Surfaces. These flats rest simultaneously against the frame and film surface to lock the profile into place during installation
d. Alignment Crest – section at the end of the Alignment Surface, nearest the Cutter Knob, that ultimately flexes the profile into the required 90-degree conformation.
e. Alignment Entrance – section at the end of the Alignment Surface nearest the Base Plate, that eases the profile into alignment
f. Cutter knob – rotating knob that drives the miter cutting blade. Rotate clockwise approximately 1 revolution to cut through the profile. The blade has a spring loaded return mechanism.
g. Profile Cutting Slot – section of tool to insert IPP for making properly mitered corner cuts.
h. Base Plate – removable Aluminum plate that secures and positions inserted profile into the proper shape during cutting. There are two sizes: one labeled “950” for use with BP950 and one labeled “700” for use with BP700. Each plate is magnetically secured into place. Each plate can be inverted depending on the type of miter joint to be cut (left-side or right-side miter cut). Each plate also has 4 narrow measuring pockets to determine how far to insert the profile into the cutting slot (see Section on Double-end Miter Cutting).
i. IPP Tool Body – general description referring to the body of the Tool, comprised of the Alignment Surfaces, Positioning Flats, Profile Cutting Slot, Blade Subassembly Cavity and Return Springs.
j. IPP Tool Top – removable section of Tool comprised of the Alignment Crests, Blade Subassembly, and Cutter Knob. This section is removed to change dull or damaged blades, and to set orientation of the blade to BP950 or BP700.

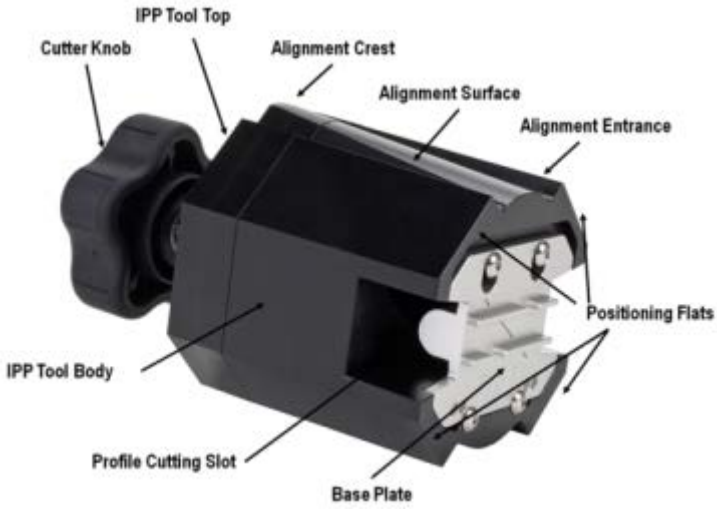

Figure 1.

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IPP Tool – General Use

⚠CAUTION
• **To reduce the risks associated with sharp cutting blades:** - Use care when repositioning or changing the cutting blade. - Discard used blades in an appropriate sharps container.
⚠CAUTION
• **To reduce the risks associated with impact:** - Secure tool with safety lanyard when working at height. - Keep bystanders away from working area.

To position or change blades:

1. Remove the two screws from the IPP Tool Top.
2. Pull the Blade Subassembly out of the IPP Tool Body.
3. To replace blade, loosen the two screws in the blade mount, carefully remove blade and safely dispose of old blade in sharps container, replace with new blade, and tighten screws to secure. Ensure that the blade is seated properly – there should be no visible gap between the blade and the blade mount clamp. IMPORTANT – use maximum torque on the screws to tighten the blade.
4. To set or change orientation of the Blade Subassembly, align the arrow on the top of the blade mount with the number indicating the IPP size on the IPP Tool Body. When arrow is pointing to “700” the blade is set for miter cutting the smaller profile, BP700; when pointing to “950”, it is set for the larger BP 950. Refer to Figure 2.

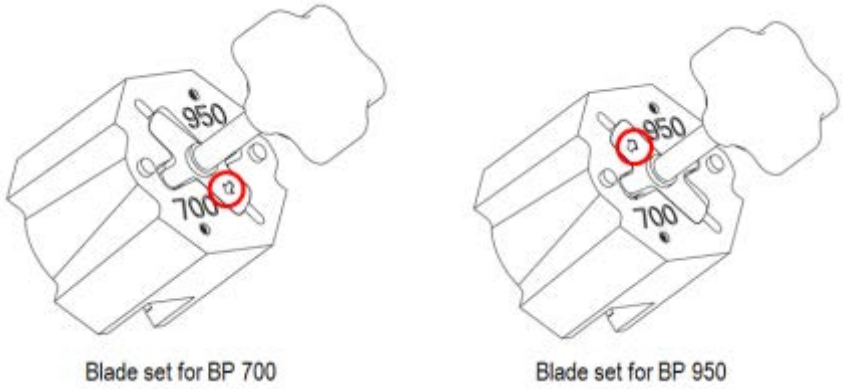

Figure 2.

5. Insert the Blade Subassembly into the cavity of the IPP Tool Body. Make sure the posts on the blade mount are inserted into the two springs in the Tool Body.
6. Rotate the IPP Tool Top so that the two Alignment Crests match the Alignment Surfaces on the IPP Tool Body.
7. Fasten the IPP Tool Top to the IPP Tool Body by reinserting the two screws.

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To verify miter cut setting without disassembling:

1. Remove the Base Plate to expose the Profile Cutting Slot
2. Inspect the position of blade angle relative to the Profile Cutting Slot. When the blade angle is tilted more towards the Cutting Slot, it is set for miter cutting BP950 profile. When the blade angle is tilted away from the Cutting Slot, it is set for miter cutting BP700 profile. Refer to Figure 3.

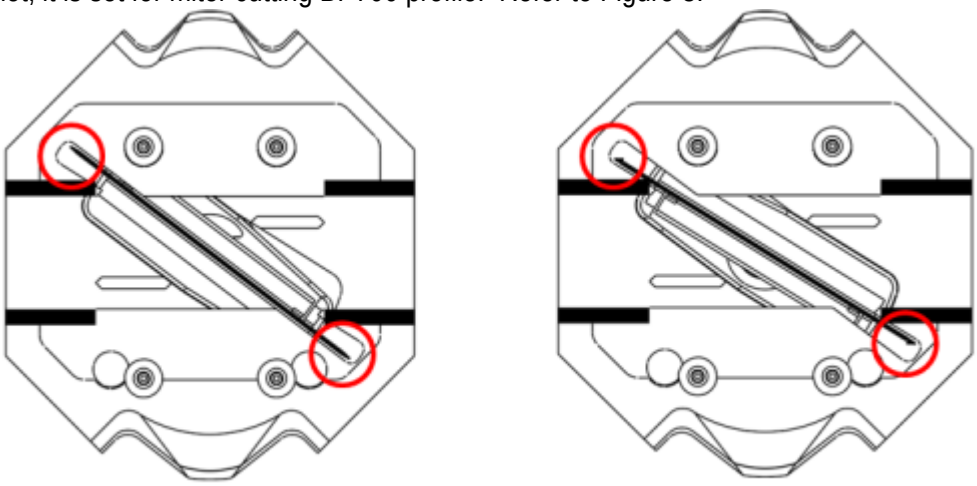

Figure 3.

To change Base Plates or Base Plate orientation:

1. The Base Plate is magnetically held into place. To remove, simply slide the plate sideways underneath the heads of the button head screws. It is not necessary to loosen or remove these screws
2. Reverse the plate orientation for left or right cuts; or insert a different plate as needed to install BP700 or BP950.

To position / align IPP on the window:

1. Place Tool over the profile such that both Positioning Flats are in full contact with window film and the frame surface. Readjust profile position if necessary to fit comfortably within the Alignment Surface.
2. Ensure the proper Alignment Surface is being used for the size profile being installed. The narrower face is used for BP700; the wider face for BP950.
3. While maintaining full contact with both Positioning Flats on the window film and frame, ***and leading with the Base Plate end of the tool***, slide the IPP Tool from one end of the profile to the other.

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To miter cut IPP:

Depending on how the profile is inserted into the Cutting Slot, a "left" or "right" end miter cut will result.

The left and right ends of the profile strips are determined by viewing the sections of the window frame (header, jambs, and sill) from the perspective of the center of the glass (See Figure 4). From this perspective, Left and Right are defined as follows:

- Header: natural L/R orientation
- Right Jamb: L = Top; R = Bottom
- Left Jamb: L = Bottom; R= Top.
- Sill: reverse L/R orientation

NOTE: Profile pieces installed along the sill should not be mitered; both ends should be cut straight.

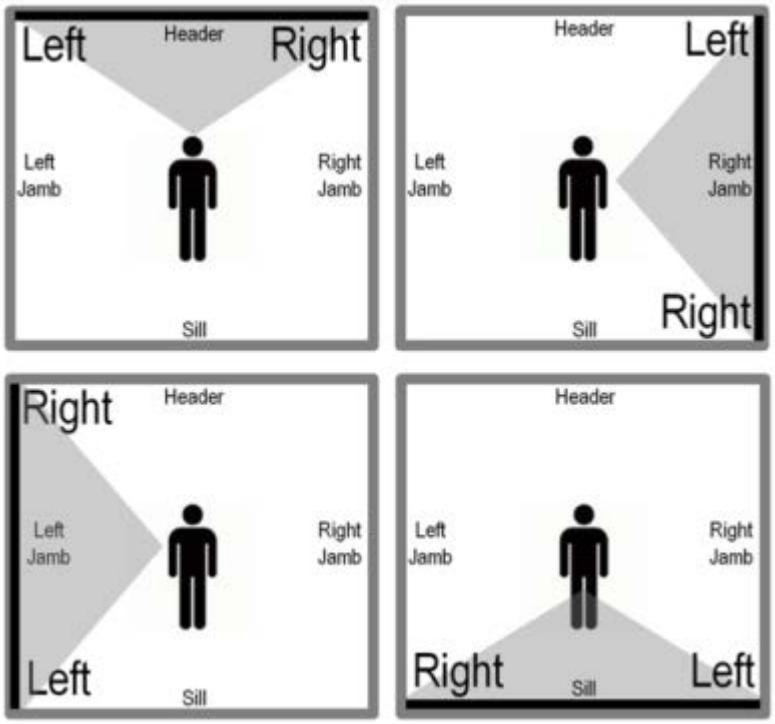

Figure 4.

⚠CAUTION
• **To reduce the risks associated with sharp cutting blades:** - Keep fingers out of path of the cutting blade when in use. - Ensure that the base plate is installed prior to use.

Left End Cut (See Figure 5):

1. Position the Base Plate with the profile support arch facing <u>inwards</u>, so that the letter "L" (for "LEFT") is visible on the bottom of the Base Plate.
2. Insert IPP into the Profile Cutting Slot until it extends to the other side. TIP: Insert only <u>straight-cut ends</u> of IPP with tape liner <u>ON</u> to avoid the profile getting stuck in the Profile Cutting Slot.
3. Cut the profile by holding the IPP Tool Body with one hand, and rotating the Cutter Knob with the other hand. Rotate the knob until it stops (about 1 revolution) to make a complete cut through the profile.
4. Release the knob to back out the blade, and pull the profile out of the cutting slot. Discard the trimmed portion of IPP.

Figure 5.

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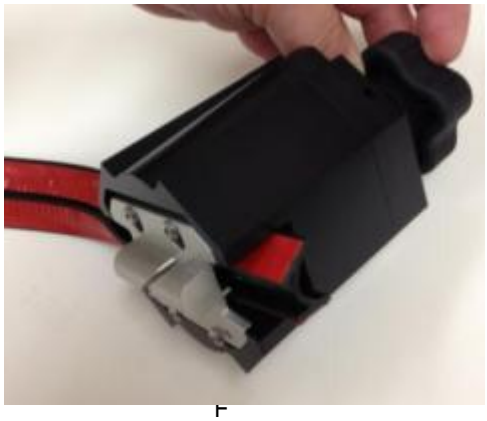
Right End Cut (See Figure 6):

1. Position the Base Plate with the profile support arch facing outwards, with the letter “R” (for “RIGHT”) visible on the bottom of the Base Plate.
2. IMPORTANT: Always flex the IPP in the same shape as the support arch of the base plate. For right-end cuts, this means the red IPP tape liner must face down (or towards the base plate).
3. Complete the cut by following steps 2-4 from the previous section. These steps are identical for left and right end cuts.



F
Figure 6.

Double-ended miter cutting (see Figure 7):

- Some profile strips require both ends to be mitered. One end is easily cut and positioned into the corner by hand. The other end, however, must be cut with the IPP already partially installed on the window.
- It is recommended that the right-end side of the profile is applied first, then finishing with a left-side miter cut at the other end.
    1. Leave the tape liner on approximately 12 inches (30 cm) from the corner requiring the double end miter cut.
    2. Mark where the profile needs to be cut. Mark the film side of the profile, not the frame side. Place a notch in the profile with a razor blade, utility knife, or mark it with a white grease pencil. Make sure the marking is visible along the very outer edge of the profile. (NOTE: for marking a right-end cut, the mark must be visible from the profile’s tape edge nearest the center).
    3. Now that you have marked where the profile must be cut, hold the IPP Tool with the Base Plate facing you, and insert the profile into the cutting slot.
    4. Insert the profile until your marking meets the measuring pocket of the Base Plate.
    5. Cut the profile and complete the installation.

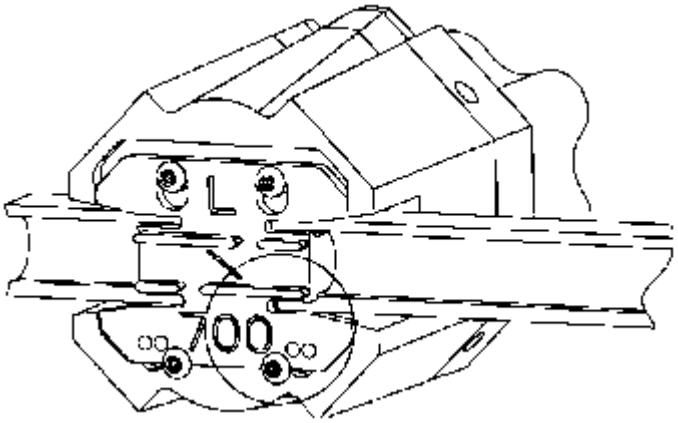


Figure 7.

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IPP Installation

1. Cut length of profiles needed for each side of window. Each strip should be cut about 2 inches (5 cm) longer than final installed length. Use a profile cutter to make straight flat cuts at the ends.

2. First install profile along the window sill (bottom of window).
   a. Remove about 6 inches (15 cm) of tape liner from one end of the profile. The section of removed liner should flare out from both sides of the profile. Avoid touching the adhesive tape with fingers to reduce contamination.
   b. Holding the edges of this end of the profile with your thumb and index finger, use your forefinger to flex the profile such that the two adhesive taps strips are perpendicular to each other. See Figure 8. Gently apply the flexed profile into the bottom corner of the window frame. IMPORTANT: Position the end of the profile about 1/8" (~3mm) from the edge of the frame jamb.

Figure 8.

   c. Gently tack down the first 6" of length from the corner by hand. To help the profile remain in alignment, gently pull it towards the other end of the window.
   d. Place the IPP tool in the corner over the section of applied profile, with the Base Plate facing towards other end. Ensure you are using the correct Alignment Surface for the specific size of profile being applied. Ensure that both flats of the IPP Tool are pressed flush against the window frame and applied window film, and that the base plate is the leading edge. Refer to Figure 9.

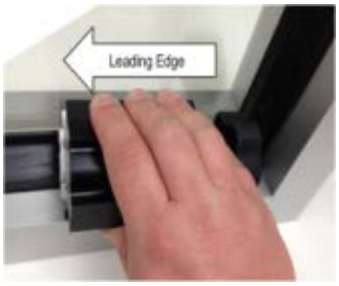

Figure 9.

   e. With one hand on the IPP Tool and the other hand on the profile, align the rest of the profile by simultaneously removing the tape liner while moving the IPP Tool across to the other end. Maintaining tension on the profile will help guide it through the Alignment Surface.
   f. Leaving the last 6 inches of tape liner on, make a straight, flat cut on the end of the profile, leaving a 1/8" (~3mm) gap from the frame jamb as before.
   g. Pull off the remaining liner and use the IPP Tool to complete alignment.
   h. Now, using the IPP Roller, apply firm pressure to the profile to activate the adhesive bond to the window. Center the wheel of the roller onto the profile and press deeply to ensure that both adhesive strips receive sufficient pressure. Use the IPP Roller along the entire length of profile.
   i. Use the handle of the roller to tack down the ends of the profile at the corners.

3. Install profile along the frame jambs (vertical sections)
   a. Create a miter cut with the IPP Tool. Refer to previous section on miter cutting IPP. Reminder: *when inserting IPP into the cutting slot, always flex IPP so it is curved in the same direction as the Base Plate arch*. Poor cutting results may occur if this instruction is not followed.
   b. Install the profile beginning with mitered end first.
   c. Repeat steps 2c – 2i to align and position the rest of the profile.
   4. Install profile along the header.
      - The last section of profile requires both ends to be mitered. The one end is mitered before installing, but the other end must be mitered while the profile is partially installed on the glass.
         a. First create a RIGHT-END miter cut.
         b. Repeat steps 2a to 2e to align and position the profile.
         c. Leave about 12" (30 cm) of liner on at the other end of the profile.

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d. To miter the other end of profile (Refer to Section on Double End miter Cutting):
   i. Place a visible mark where the film side edge of the profile needs to be cut.
   ii. Set the base plate for a LEFT-END miter cut.
   iii. Insert the profile through the cutting slot until the marking meets the measuring pocket on the Base Plate. Cut the profile at this mark.
   iv. Repeat steps 2g to 2i to complete the installation.

Care, Maintenance, and Disposal

⚠ CAUTION
• **To reduce the risks associated with sharp or rough edges:** - Do not use tool if any part of it is damaged.
• **To reduce the risks associated with sharp cutting blades:** - Keep fingers out of path of the cutting blade when in use. - Use care when repositioning or changing the cutting blade. - Remove blade prior to disposal of the tool. - Discard used blades in an appropriate sharps container.
• **To reduce the risks associated with impact:** - Replace springs only with Part. No. 9657K414 available from McMaster-Carr (Steel Compression Spring Zinc-Plated Music Wire, 2.50" L,.375" OD,.035" Wire) or a spring of equivalent dimensions and compressive energy.

- Take care not to drop the tool, which could damage parts, causes dents along critical surface areas, or compromise its function. Do not use the tool if any part of it is damaged.
- Do not use if blade becomes dull or damaged. A dull blade will result in less precise cuts. To change the blade, refer to previous instructions on changing blades.
- If the nut inside the IPP Tool Top begins to rotate or recess out of the tool, check to make sure the two set screws in the IPP Tool Top are properly embedded into the nut.
- Dispose of blades in an appropriate sharps container
- If the tool becomes unusable, remove the blade and the tool may be disposed of in the regular trash.

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3M™ Window Film
3M™ Impact Protection Adhesive
Installation Instructions

IPA tubes and sausages are only available through your 3M Window Film distributor.

The following procedure describes the materials and steps that are necessary to install the 3M™ Impact Protection Adhesive attachment system.

Recommended Products:

- 3M™ Citrus Base Cleaner
- 3M™ Adhesive Remover, Citrus Base
- 3M™ Foaming Glass Cleaner
- 3M™ Super Fine Synthetic Steel Wool Pad
- 3M™ Scotch™ Safe-Release™ Masking Tape
- 3M™ Scotch™ Long-Mask™ Masking Tape
- 3M™ Impact Protection Adhesive

Window Preparation

Glass panel shall be uniform in appearance. No fractures, holes or what is considered contaminated glass, or damaged glass, to be present.

Window frame to be uniform in appearance and free from dents, holes and cracks within two inches of the glass.

A thorough cleaning of the glazing and frame systems before applying film and attachment is required to remove all foreign matter and contaminants such as adhesives, grease, oil, dust, water, surface dirt, old sealant or glazing compounds by using 3M Citrus Base Cleaner, alcohol or commercial cleaning solution.

Detergent or soap and water treatments are not recommended for this step.

1. IPA does not require the glazing stop to be trimmed. Note: If the glazing stop overlaps frame, trimming the glazing stop is optional. (Reference Detail 1 on back.)

2. Spray the glazing bead, glass and frame surface with an appropriate cleaning product and remove with a lint free cloth. Repeat if necessary to remove all foreign materials from the glass and inside window frame surfaces. If the area is particularly dirty, a light scrub with a 3M 0000 Super Fine Synthetic Steel Wool Pad is recommended to loosen contaminates. Finish with a final cleaning if needed.

3. Spray the glass with 3M Foaming Glass Cleaner or a soap and water solution. Flush the glazing bead to glass area starting at the top and working down to drain or remove any remaining contaminant from the area. Scrape the glass with a razor to remove all foreign matter. Thoroughly clean the glass a final time with soapy water and a window cleaning squeegee. Wipe around the glazing bead and frame area one final time to remove all of the soap and water solution.

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3M™ Impact Protection Adhesive

Installation Instructions

Film Installation

1. Apply the 3M™ Safety & Security Window Film Ultra Series to the glass, making sure that the film is installed as far into the glazing channel as possible. Cut film as you normally would around the remaining glazing bead. Remember to leave enough spacing between film and glazing bead to facilitate the removal of the slip solution**.**

2. Squeegee the film to the glass by pressing firmly to remove as much of the slip solution as possible, especially at the edges of the film. Two “edge-drying” methods can be used before applying the Impact Protection attachment system.

A. The panels can be left for a few weeks to ensure proper drying of the film before the IPA system is applied.

– OR –

B. Using a hair dryer, gently heat and bump the edges of the film to hasten the removal and drying of the water from the edges. Make sure that all of the soap and water solution has been removed from the film/glass/glazing channel before applying the IPA attachment system.

Attachment System Installation

1. Apply a 1" (25mm) strip of 3M™ Scotch™ Safe Release™ White Masking Tape to the Ultra film surface 3/8" (9mm) in from the edge of the film to all four sides. Note: This dimension will depend on application—1/2" or 3/8".

2. Apply a 1" (25mm) strip of 3M Safe Release Blue Masking Tape to the window frame 3/8" (9mm) from the edge of the trimmed gasket. This will form a parallel sealant channel that will allow a uniform sealant bead to be applied to the glass/frame interface. Note: Use a clean drop cloth before proceeding to Step 3.

3. Apply a triangular bead of IPA Impact Protection Adhesive, and tool as needed to form an acceptable finish. Refer to Figure 1. Read and follow all product information and installation instructions provided by 3M Company. We recommend you start in a corner and apply the sealant bead out approximately 6". Then turn the gun and push the sealant bead to the next corner where the same method is repeated. Pushing the sealant bead will insure proper penetration and minimize the chances of air gaps in the bead. Pulling the gun can also be done if confident no air gaps are formed.

4. Smooth the sealant bead with an appropriate tool, if necessary, to give a finished look. Tooling should be completed in one continuous stroke immediately after adhesive application and before a skin forms.

5. Carefully remove the two masking strips from the glass/frame immediately after tooling. Do not allow the excess adhesive to contact the film, frame or flooring surfaces. A light colored drop cloth is needed to protect the work area. Be careful not to step on adhesive and transfer it to surrounding surfaces.

Note: Should you get some of the adhesive on the surrounding surfaces, an application and gentle wipe with a 3M Citrus Based Cleaner is recommended.

Curing time for the IPA will vary depending on temperature and relative humidity. It is not recommended to clean the film/IPA system for at least 36 hours following the installation. Full curing/adhesion can take up to 7 days, depending on conditions.

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AAMA
American Architectural Manufacturers Association. A national trade association that establishes voluntary standards for the aluminum window, door, and skylight industry.

ABSORPTANCE
The fraction of incident radiation that is absorbed.

ACRYLIC (Plastic, Plexiglas)
A non crystalline thermoplastic with good weather resistance, shatter resistance, and optical clarity; sometimes used for glazing instead of glass.

ADHESION
The ability or level of a coating or sealant to stick or bond to the surface to which it is applied.

ADHESIVE FAILURE
Failure of a compound by pulling away from the surface with which it is in contact. (See cohesive failure.)

ALLOY
A metal to which another element has been added, generally another metal.

ANNEALED GLASS
Standard sheet or plate glass.

ANNEALING
To heat above the critical or re-crystallization temperature, then controlled cooling of glass or other materials to eliminate the effects of cold-working, relieve internal stresses or improve strength, ductility, or other properties.

ANSI
American National Standards Institute. Clearing house for all types of standards and specifications.

ASHRAE
Abbreviation for the American Society of Heating, Refrigerating and Air-conditioning Engineers.

ASTM
American Society for Testing and Materials. A society of engineers which sets standards for testing of materials.

BOCA
Building Officials and Code Administrators.

BRONZE
An alloy of copper and tin. Also a color.

BTU (British Thermal Unit)
The energy used for heating and cooling is measured by the number of BTUs needed to keep a building at a comfortable temperature. Scientifically, it is the amount of heat energy necessary to raise the temperature of one pound of water one degree Fahrenheit (1 Btu = 252 calories).

CABO
Council of American Building Officials.

CCF
An abbreviation for one hundred cubic feet. A unit of natural gas consumption. Equivalent to 100,000 Btu's (105.5 MJ) of energy or heat.

CLOUDINESS INDEX
The percent of extraterrestrial radiation that reaches the earth surface when measured on a horizontal plane.

COHESIVE FAILURE
Splitting and opening of a compound resulting from over-extension of the compound. (See adhesive failure)

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3M™ Window Film
Terms and Definitions

COMPATIBILITY
The ability of two or more materials to exist in close and permanent association for an indefinite period with no adverse effect of one on the other.

CONDENSATION
When water vapor, which is present in all but the driest air, comes in contact with a surface that is below the "dew point temperature," the vapor becomes liquid and is called condensation. An example is as follows: Condensation forms on a glass of ice water since the surface of the glass is down to the dew point temperature of the inside air.

CONDUCTION
Process to heat transfer through a material from a warm surface to a cool surface.

CONDUCTION FACTOR
The difference in the "U-values" before and after film application to glass multiplied by 24 hours/day. This factor is used in calculating heating energy savings.

CONVECTION
Heat transfer by the movement of fluid or air.

COOLING DAYS
The number of days in a year that the air conditioning equipment is used.

COOLING DEGREE-DAY
Cooling and heating engineers have found a way to relate the typical climate conditions of different areas to the amount of energy needed to cool and heat a building. The term is "Degree-Day" using a base temperature of 65°F (18°C). A cooling degree-day is counted for each degree above 65°F (18°C) reached by the average (between the highest and lowest) daily outside temperatures in the summer. For example, if on a given summer day the high is 90°F (32°C) and the low is 70°F (21 °C), the daily average temperature is 80°F (26°C).This is 15°F (8°C) above the base temperature of 65°F (18°C difference). So, on that day, you would have gone through 15 (8) cooling degree-days.

CORROSION
The deterioration of metal by chemical or electro-chemical reaction resulting from exposure to weathering, moisture, chemicals, or other agents or media.

CRF (Condensation Resistance Factor)
Gives an indication of a window's ability to resist condensation. The higher the CRF, the less likely condensation is to occur.

CURTAIN WALL
An exterior building wall which carries no roof or floor loads and consists entirely or principally of metal, or a combination of metal, glass, and other surfacing materials supported by a metal framework. There are two basic types:
CUSTOM: Walls designed specifically for one project, and using parts and details specially made for this purpose.
STANDARD: Walls made up principally of parts and details standardized by their manufacturer and assembled in accord with either the architect's design or the manufacturer's stock patterns.

DEGREE-DAY
A unit that represents a 1°F (1°C) deviation from some fixed reference point (usually 65°F [18°C]) in the mean, daily outdoor temperature. (See heating degree-day and cooling degree day)

DESICCANT
An extremely porous crystalline substance used to absorb moisture from within the sealed air space of an insulating glass unit.

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Terms and Definitions

DEW POINT
The temperature at which the water vapor condenses to become liquid. Used in testing sealed insulated glass. The lower the number, the higher the resistance to forming condensation.

DOUBLE GLAZING
In general, any use of two panes of glass, separated by an air space, within an opening, to improve insulation against heat transfer and/or sound transmission. In factory-made double glazing units the air between the glass sheets is thoroughly dried and the space is sealed airtight, eliminating possible condensation and providing superior insulating properties. (See sealed insulating glass.)

EDGE CLEARANCE
The distance between the edge of a unit of glass or panel and its surrounding frame, measured normal to the edge in the plane of the glass or panel.

ELASTICITY
Pliability, ability to take up expansion and contraction; opposite of brittleness.

EMI
An abbreviation for Electromagnetic Interference.

EMISSIVITY
This is a measure of the ability of a surface to emit room temperature radiant heat energy. It is also a measure of the ability of the surface to reflect room radiant energy since, for window systems. The emissivity and the reflectivity of room radiant energy add up to unit. Low emissivity means a high reflectivity of room radiant energy.

EXTERIOR GLAZED
Glass set or installed from the exterior of the building.

FLOAT GLASS
Glass which has its bottom surfaces formed by floating on molten metal, the top surface being gravity formed, producing a high optical quality of glass with parallel surfaces and, without polishing and grinding, the fire-finished brilliance of the finest sheet glass. Float glass is replacing plate glass.

FOGGING
A deposit of contamination left on the inside surface of the sealed insulating glass unit due to extremes of temperatures. Usually happens with failed sealed insulated glass.

GLARE REDUCTION
This is the ratio of the difference in visible transmission of the glass before and after installing him to the visible transmission of the glass with no film. It is expressed as a percentage and is determined by the respective visible transmission values of the glass with and without film.

GLASS
A transparent, brittle substance formed by fusing sand with soda or potash or both; it often has lime, alumina or lead oxide.

GLASS EDGE STRESS
An amount of force in pounds per square inch (psi) (kg/cm2) experienced by the edge of the glass pane.

GLASS THERMAL STRESS
An applied force, caused by absorbed solar heat, that tends to strain or deform glass.

GLAZING
The work of installing glass in a frame.

GLAZING BEAD
A molding or stop around the inside of a frame to hold the glass in place.

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3M™ Window Film
Terms and Definitions

GLAZING COMPOUND
: A soft dough-like material used for filling and sealing the space between a pane of glass and its surrounding frame.

HEAT GAIN
: The transfer of heat from outside to inside. Both heat loss and heat gain are measured in terms of the fuel consumption required to maintain a comfortable indoor temperature.

HEAT LOSS REDUCTION
: This is the ratio of the difference in heat loss through the glass after installing film to the heat loss through the glass with no film It is expressed as a percentage and is determined by the respective “U” values of the glass with and without film.

HEATING DAYS
: The number of days in a year that the heating equipment is used.

HEATING DEGREE-DAY
: Heating and cooling engineers have found a way to relate the typical climate conditions of different areas to the amount of energy needed to heat and cool a building. The term they use is “Degree-Days” using a base temperature of 65°F (18°C).A heating degree-day is counted for each degree below 65°F (18°C) reached by the average (between the highest and lowest) daily outside temperatures in the winter. For example, if on a given winter day the high is 40°F (4°C) and the low is 20°F (-6°C), the daily average temperature is 30°F (-1°C). This is 35°F (19°C difference) below the base temperature of 65°F (18°C). So, on that day, you would have gone through 35 (19) heating degree-days.

HEAT LOSS
: The transfer of heat from inside to outside by means of conduction, convection, and radiation through all surfaces of the building.

HEAT STRENGTHENED GLASS
: Glass which is reheated, after forming, just below melting point and then cooled. A compressed surface is formed which increases its strength. Often used for spandrel glass.

HERMETICALLY SEALED UNIT
: An insulated glass unit made up of two lites of glass, separated by a roll formed aluminum spacer tube (at the full perimeter) which is filled with a moisture absorbing material. The unit is then completely sealed, creating a moisture free, clean, dead air space.

HUMIDITY, RELATIVE
: The percentage of moisture in the air in relationship to the amount of moisture the air could hold at that given temperature. 100% relative humidity would be rain.

HVAC
: An abbreviation for Heating, Ventilating, and Air Conditioning equipment.

ICBO
: International Conference of Building Officials.

INFILTRATION (air)
: The movement of outdoor air into the interior of a building through cracks around windows and doors or in walls, roofs. and floors.

INSULATING GLASS
: Insulating glass refers to two pieces of glass spaced apart and hermetically sealed to form a single-glazed unit with an air space between. Heat transmission through this type of glass may be as low as half that without such an air space. It is also called Double Glazing.

INTERIOR GLAZED
: Glass set from the interior of the building.

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3M™ Window Film
Terms and Definitions

INTERIOR STOP
The removable glazing bead that holds the glass in place, when it is on the interior side of the lite, as contrasted to an exterior stop which is located on the exterior side of a glass or panel.

JALOUSIE
The jalousie window is made up of horizontally-mounted louvered glass that abut each other tightly when closed and extend outward when cranked open.

KWH
An abbreviation for kilowatt-hour. A unit of electric power consumption. Equivalent to 3413 Btu's of energy or heat. (1 kWh = 3.60 MJ)

LAMINATED GLASS
Two or more sheets with an inner layer of transparent plastic to which the glass adheres if broken. Used for overhead, safety glazing, and sound reduction.

LITE
Another term for a pane of glass used in a window. Frequently spelled "light" in the industry literature, but spelled "lite". In this text to avoid confusion with light as in "visible light".

LOW-EMISSIVITY GLASS
Glass which restricts the passage to radiant heat, in and out; a metal or metal oxide coating applied to the glass to provide low emissivity.

MAXIMUM HEAT GAIN
The maximum per hour amount of solar heat coming through one square foot of glass. Measured in units of Btu/hr/sq.ft. (W/m2).

MCF
An abbreviation of one thousand cubic feet. A unit of natural gas consumption. Equivalent to 1,000,000 Btu's (37,300 Kj/m3) of energy or heat.

MLB
An abbreviation for one thousand pounds.A unit of steam consumption. Equivalent to 1,000,000 Btu's (2330 kJ/kg) of energy or heat.

MOISTURE CONTROL
The use of humidifiers, air conditioners, or ventilation to keep the humidity of the home at acceptable levels. Also refers to vapor barriers.

MONOLITHIC
A single piece of glass.

MULLION
An intermediate connecting member used to "marry" two or more windows or patio doors together in a single rough opening without sacrificing air or watertight performance. A mullion also can give added strength to the connection for structural stability.

MUNTINS
A decorative design in cut-ups of glass lites.
1) Painted muntin grids (enamelite) applied to an interior lite of glass in a sealed insulated glass unit to simulate cut-ups of glass lites either in colonial or diamond patterns.
2) Use of aluminum muntin bar between lites of glass in a sealed insulated glass unit to simulate glass cut-ups.
3) Use of actual vertical and horizontal bars to divide windows into smaller lites of glass.The bars are termed muntin bars.
A synthetic rubber having physical properties closely resembling those of natural rubber but not requiring sulphur for vulcanization. Extremely good weather resistance, both heat and cold, with ultraviolet stability.

NOAA
National Oceanic & Atmospheric Administration.

NON-FERROUS METALS
Metals or alloys that are free of iron, such as aluminum.

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3M™ Window Film
Terms and Definitions

OBSCURE GLASS
Mainly used for decoration, diffusion, or privacy. The design is pressed into the glass during the rolling process. There are many patterns available.

ORGANIC COATING
A coating such as paint, lacquer, enamel, or plastic film in which the principal ingredients are derived from animal or vegetable matter or from some compound of carbon (which includes all plastics).

PASSIVE SOLAR HEAT GAIN
Solar heat that passes through a material and is captured naturally, not by mechanical means. (ex Large windows facing south will take advantage of passive solar heat gain in Northern Hemisphere.)

PAYBACK
Savings from reducing energy cost and seeing this reflected in your heating/cooling bills

PERMEABILITY
The quality of permitting passage of water through openings without causing rupture or displacement

PLATE GLASS
Polished plate glass is a rolled. ground, and polished product with true flat parallel plane surfaces

POLYCARBONATE
Any of a family of thermoplastics characterized by a high softening temperature and high impact strength (Lexan).

POLYSULFIDE
Polysulfide liquid polymers are mercaptan terminated, long chain aliphatic polymers containing disulfide linkages. They can be converted to rubbers at room temperature without shrinkage upon addition of a curing agent. Used for exterior sealant and sealed insulating glass sealant.

PSF
Pounds per square foot (lbs/ft2) (kg/m2) Abbreviation of pressure notation, used to describe wind pressure, barometric pressure.

PSI
Pounds per square inch - (lbs/in2) (kg/cm2) as above.

PSYCHROMETER
An apparatus used to determine the relative humidity by determining the wet bulb temperature of the air. It is a very accurate means of determining relative humidity.

RADIATION
Transmission of heat through space by wave motion; passage of heat from one object to another without warming the space between, such as sun light.

REFLECTANCE
The fraction of the incident light that is reflected.

RELATIVE HEAT GAIN
The amount of conduction heat gain plus solar heat gain, measured in terms of energy units per hour per square foot (compare U-Value). (Btu/hr/sq.ft. or W/m2).

RFI
An abbreviation for Radio Frequency Interference.

ROI
Return on investment.

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3M™ Window Film
Terms and Definitions

"R" VALUE
A measure of resistance to heat gain or loss (insulative ability). "R"-Values rather than thicknesses can be compared for different materials, since 6" (152mm) of fiberglass (R-19 [R-34]) might compare with 12" (305mm) of wood or 18' (15.5m) to stone. "R"-Value of some common substances of 1" (25mm) thickness: Concrete 0.1 (0.018) Stucco and brick 1.2 (0 21) Plywood 1 (0.18) Sawdust 2 (0.36) Fiberglass batts 3 (0.54) Polystyrene 6.25 (1.10) Polyurethane foam 7.7 (1.36)

SBCC
Southern Building Code Congress International.

SEALANT
An elastomeric material with adhesive qualities that joins components of a similar to dissimilar nature to provide an effective barrier against the passage of the elements.

SHADING COEFFICIENT
This is a ratio of the solar energy entering through a window compared to that which enters through a window of clear 1/8" (3mm) double strength sheet glass. The solar energy which enters includes both that which is transmitted directly through the window and that portion of the energy absorbed in the window that is transferred to the interior.

SHEET GLASS
A transparent, flat glass whose surface has a characteristic waviness. There are three basic classifications of sheet glass
1) Single strength (S.S.): 3/32" (2.4mm) thick.
2) Double strength (D.S.): 1/8" (3.2mm) thick.
3) Heavy sheet which has three available thicknesses 3/16" (4.8mm), 7/32" (5.6mm), and 1/4" (6.4mm).

SHELF LIFE
The length of time that packaged materials such as adhesives and sealants can be stored under specific temperature conditions and still remain suitable for use.

SIG
(Sealed Insulated Glass) - See insulating glass.

SOLAR ENERGY SPECTRUM
Solar radiation is typically divided into three categories, namely, the ultraviolet, the visible and the near infrared portions of the spectrum. All three portions result in heat when the solar radiation is absorbed. At the earth's surface, approximately 3% of the solar energy is in the ultraviolet portion, 44% is in the visible portion and 53% is in the near infrared.

SOLAR HEAT GAIN
The amount per hour of solar heat coming through a square foot of glass Measured in units of Btu/hr/sqft. (W/m2).

SOLAR HEAT REDUCTION
This is the ratio of the difference in total solar energy entering before and after installing film on the glass to that entering through the glass with no film. It is expressed as a percentage and is determined by the respective shading coefficients of the glass with and without film.

SPANDREL GLASS
Heat-strengthened float glass with a colored-ceramic coating adhered to the back by a heat-fusing process. It has double the strength of annealed glass of the same size and thickness; enabling it to withstand greater uniform loads and thermal stresses. Spandrel glass cannot be re-cut after heat strengthening. It is used as fixed opaque colored glass on buildings in front of floor slabs and columns. It is available in a wide array of colors.

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Terms and Definitions

SPECTROPHOTOMETER
An instrument for measuring the transmittance and reflectance of surfaces and media as a function of wavelength.

SUNLIGHT
The portion of solar energy which is detectable by the human eye; it accounts for about 44% of the total solar energy. As with heat strengthened glass, it is re-heated to just below the melting point but suddenly cooled. When shattered, it breaks into small pieces. It is approximately five times stronger than standard annealed glass. It must be used as safety glazing in patio doors, entrance doors, side lites, and other hazardous locations. It can't be re-cut after tempering.

TENSILE STRENGTH (Also called ultimate strength)
The breaking strength of a material when subjected to a tensile (stretching) force. Usually measured by placing a standard piece in the jaws of a tensile machine gradually separating the jaws and measuring the stretching force necessary to break the test piece. Tensile strength is commonly expressed as pounds (or tons) per square inch (kg/m2) of original cross sectional area.

THERM
100,000 Btu's (105.5 MJ) to energy or heat.

TINTED GLASS
A mineral admixture is incorporated in the glass, resulting in a degree to tinting. Any tinting reduces both visual and radiant transmittance.

TON-HR
A unit to air conditioning consumption equivalent to 12,000 Btu's (3024kcal) to energy.

TOTAL SOLAR ENERGY
When solar radiant energy strikes the exterior surface of a window, the energy is reflected, absorbed and/or transmitted as defined above. The total of these three parameters must add up to 100%.

TOTAL SOLAR ENERGY ABSORBED
This is a ratio of the solar energy that is absorbed by the window and converted to heat in the window to the total solar energy impinging on the window. It is typically expressed as a percentage.

TOTAL SOLAR ENERGY REFLECTED
This is a ratio to the solar energy that is reflected directly away by the window to the total solar energy impinging on the window. It is typically expressed as a percentage.

TOTAL SOLAR ENERGY TRANSMITTED
This is a ratio to the solar energy that is transmitted directly through the window where it is absorbed by interior surfaces to the total solar energy impinging on the exterior window surface. It is typically expressed as a percentage.

TRIPLE GLAZED
Three panes of glass separated by air spaces.

UBC
Uniform Building Code.

UL
Underwriters Laboratory.

ULTRAVIOLET
The invisible rays to the spectrum which are outside of the visible spectrum at its violet end. UV rays are found in everyday sunlight and can cause fading or chalking to dark paint finishes. Extreme UV exposure can cause certain plastic materials to distort.

NOTE: On the basis to practical applications and the effect obtained, the ultraviolet region often is divided into the following wavelengths:

UV-A ..... 315-400 nanometers
UV-B ..... 280-315 nanometers
UV-C ..... 100-280 nanometers

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3M™ Window Film
Terms and Definitions

UV REDUCTION

This is the ratio to the difference in ultraviolet transmission of the glass before and after installing film to the ultraviolet transmission to the glass with no film. It is expressed as a percentage and is determined by the respective UV transmission values in the glass with and without film.

"U"-VALUE

The measurement used in determining the ability of different structural components (such as windows) to conduct heat. The "U"-Value of a window is measured by the number of Btu's that will pass through each square foot of area per degree of temperature difference (W/m2-°C) from one side of the window to the other. "U"-Values can tell you how well your windows will hold in your heated or cooled air. The lower the number the better.

VISCOSITY

The internal resistance to flow exhibited by a fluid. The higher the number, the thicker the fluid.

VISIBLE LIGHT REFLECTED

Visible light is defined as that portion of the solar energy spectrum under average daylight conditions that is visible to the human eye and the values given are based on the response of the human eye. The ratio of that which is reflected away from the surface of the window to that impinging on it is called the percent of visible light reflected.

VISIBLE LIGHT TRANSMITTED

This is a ratio of the human eye weighted average daylight that is transmitted through the window to that which is incident upon the window.

VISIBLE RADIATION

The spectrum containing radiation with wavelengths in a narrow band from about 400 nanometres (violet) to 750nm (red).At the earth's surface about half the solar energy is in the visible range.

WAVELENGTHS

Wavelength is the distance between two successive points to a periodic wave in the direction to propagation, in which the oscillation has the same phase. The three commonly used units are listed in the following table

Name	Symbol	Value
Micrometer	*u*m	1 *u*m z 10-6 m
Nanometer	nm	1 nm = 10-9 m
Angstrom	A	1 A= 10-10 m

WINDOW TYPES

AWNING — A partially movable sash hinged at the top, and opening either outwards or inwards.

CASEMENT — A window sash hung by hinges fastened to the jamb to the window frame.

DOUBLE HUNG — Consists to a pair to vertical sliding sash, either sash opening independently of the other. Older type double hung sash operate through a system of weights, springs, or pulleys.

FIXED — A single sash fastened permanently in a frame so that it cannot be raised, lowered, or swung open.

HOPPER — A partially movable sash hinged at the bottom and opening inwards.

revolving on pivots at either side of the sash or or at top and bottom.

SINGLE HUNG — A window frame containing a pair to vertical sliding sashes in which only one sash is movable, usually the lower in contrast to a double hung sash.

SLIDING — A sash which moves horizontally on a track.

STORM — A full length sash, either fixed or movable, fitted to the outside or inside of a window frame to afford protection during cold or stormy weather.

WIRE GLASS

Polished or clear glass, 1/4- (6mm) thick. Wire mesh is embedded within the glass such that the glass will not shatter when broken. The wire pattern is available in many types. It is frequently used in skylights, overhead glazing, and locations where a fire-retardant glass is required.

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3M™ Window Film
List of Appendices (separate documents)

Appendix A – Technical Data and Specifications

Product Performance Tables
Product Technical Datasheets
Specifications

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