The General Services Administration

Firefighter Forcible Entry Tutorial Manual

PRESENTED BY:

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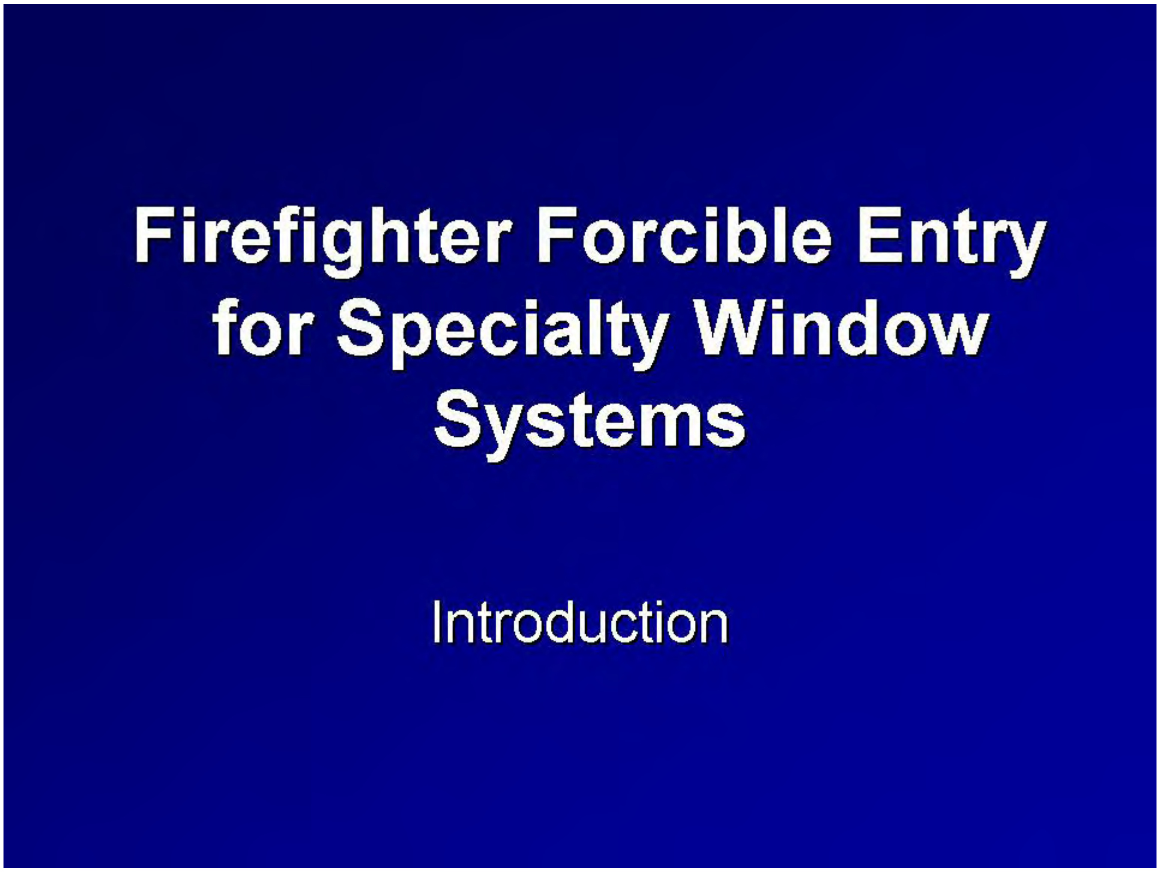
Preface

This training manual was designed to accompany the Firefighter Forcible Entry Tutorial. The manual mirrors the online tutorial, and therefore is best utilized in conjunction with it. You may want to print this manual to follow along with the tutorial. This document contains images and text only. To view the movies described in this document, view the online tutorial.

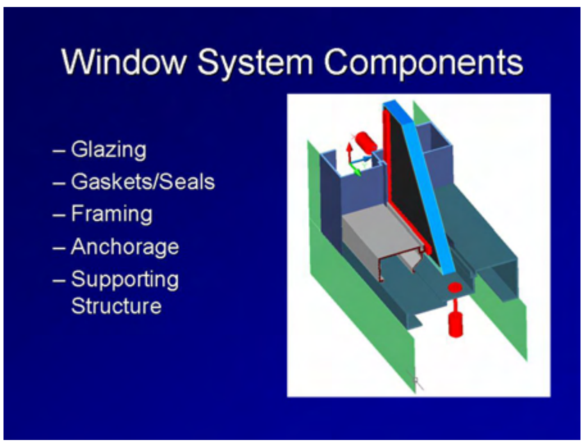


Purpose

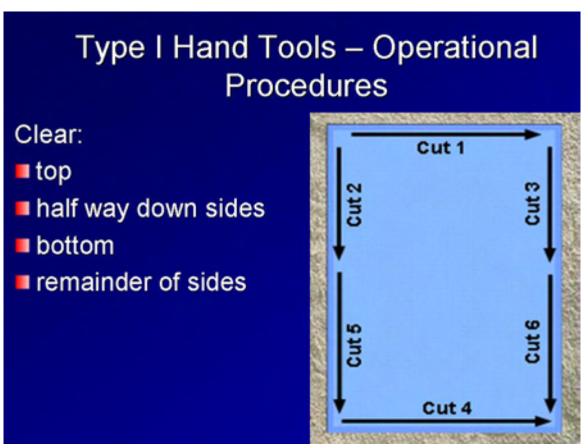
Current advances in window systems design and glazing materials provide mitigation to glazing hazards resulting from hurricanes, tornadoes, ballistics, and explosive effects. These hazards have been proven to be significant and result in loss of life.

In response to such events, many facilities have incorporated security windows and retrofits to existing windows in order to protect occupants from glass fragments that may result from blast, ballistic, or hurricane hazards. This training outlines the need for using blast, hurricane, and ballistic resistant windows.

The security windows and retrofitted windows are harder to break than typical windows and will provide unexpected resistance to forcible entry to an unsuspecting and unprepared firefighter.



Window systems are described, and their components are defined.

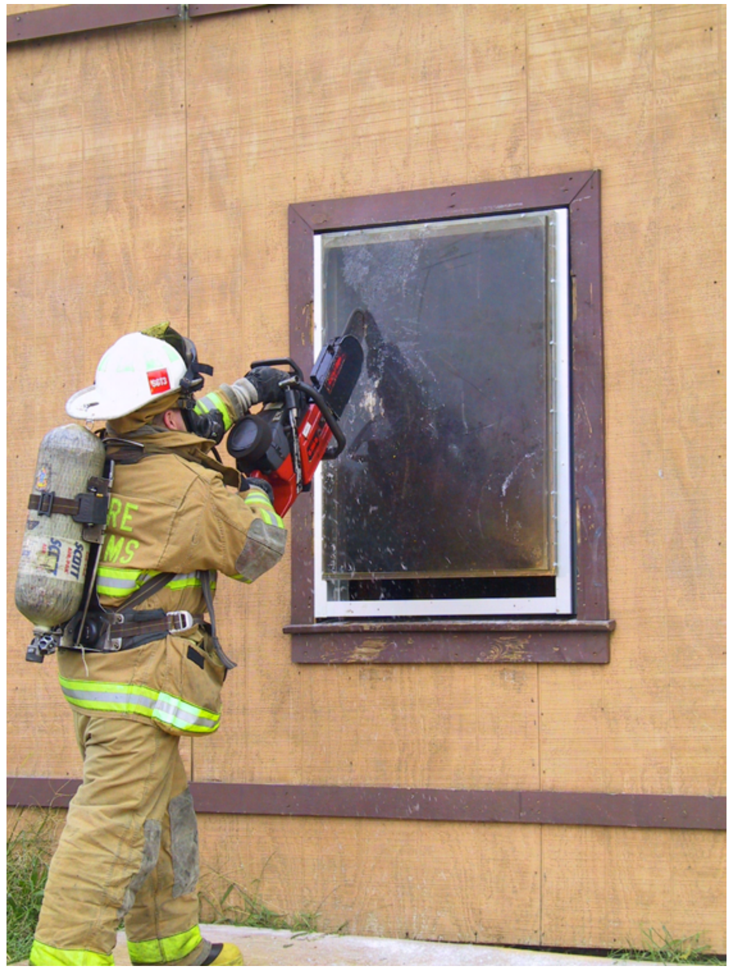


Finally, the training educates firefighters and facility tenants to the potential forcible entry and emergency escape issues of security windows and offers techniques for venting and for forcible entry.

Challenge

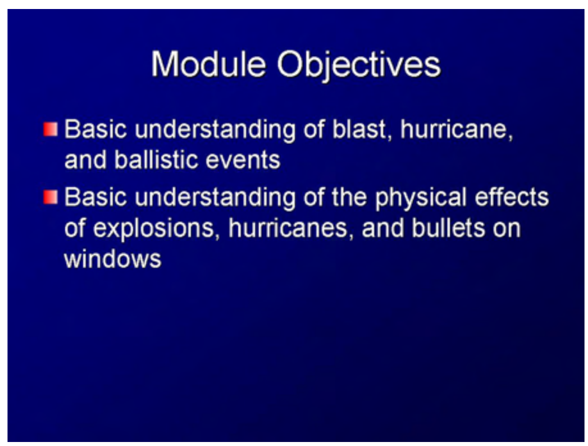
Some windows with new upgrades can be extremely difficult to break as seen by the effort exhibited by the firefighter in this video.

Not all specialty windows are as difficult to enter as this one. However, the specialty windows discussed in this training will provide greater resistance and will require more time for forcible entry than a typical window system.



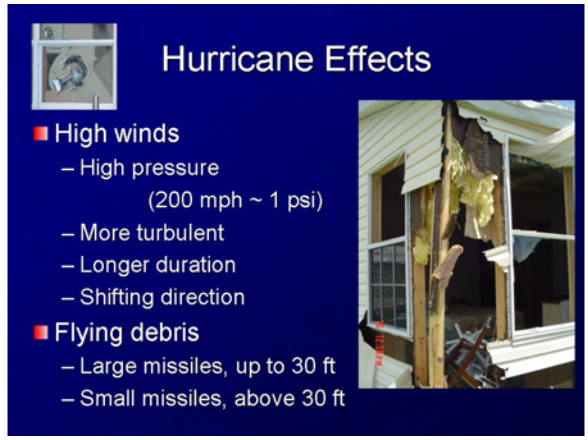
Introduction

This section presents general information on blast, ballistic and hurricane effects on windows. This will help you become more familiar with the terminology and window protection technology developed by industry. Advancements have been made in window system design and glazing material to resist these abnormal loadings.



Hurricane Effects

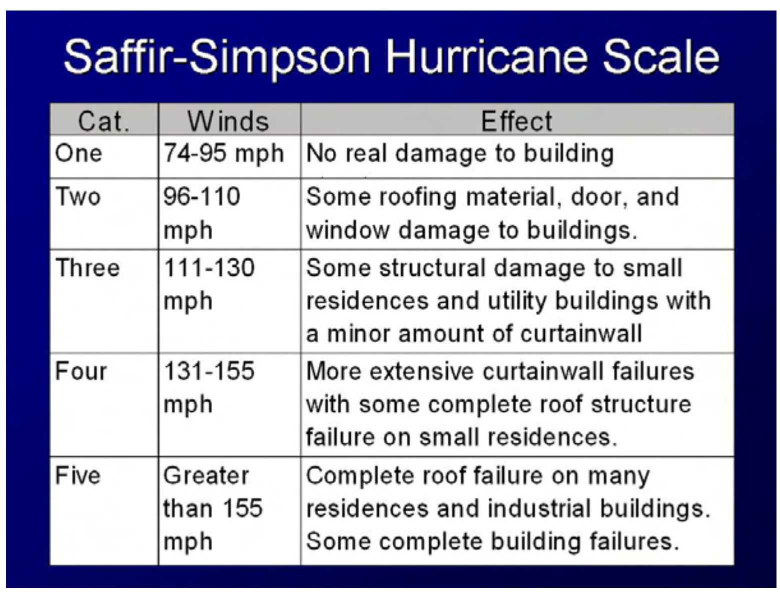
Hurricanes deliver high force winds that develop high pressures on buildings and structures in their path. A 200 mile per hour wind can generate 1 pound per square inch (psi) pressure on building surfaces. Typical window systems fail between 0.25 and 1 psi. In addition to the high pressures, the turbulent and shifting nature of hurricane winds can tend to pick up everyday objects and turn them into flying debris, which may impact buildings and cause damage.



Hurricane resistant windows are designed to resist the impact of these objects. When talking about hurricane resistant windows, flying debris is divided into two categories: large and small missiles.

Damage from large missiles is typically found on the lower 30 feet of a building. Current hurricane resistant window systems are designed for a 9 pound 2x4 piece of lumber traveling at 33 mph. Small missiles are typically found above the 30 foot level of a building. These window systems are designed for 2 gram steel ball bearings traveling at 88 mph.

The Saffir-Simpson Hurricane Scale assigns categories to varying levels of wind speed and equates expected damage levels to each of the categories. Window damage and hazardous failure can be expected in category 2 - 5 hurricanes.

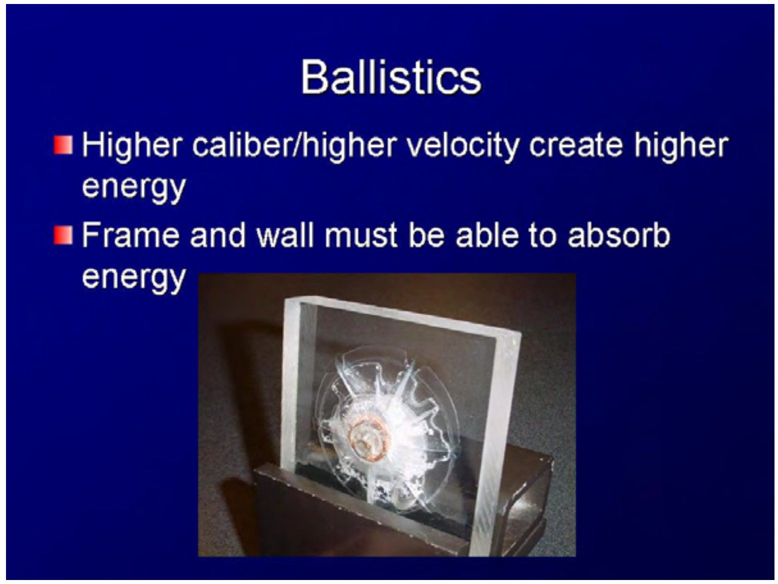


Cat.	Winds	Effect
One	74-95 mph	No real damage to building
Two	96-110 mph	Some roofing material, door, and window damage to buildings.
Three	111-130 mph	Some structural damage to small residences and utility buildings with a minor amount of curtainwall
Four	131-155 mph	More extensive curtainwall failures with some complete roof structure failure on small residences.
Five	Greater than 155 mph	Complete roof failure on many residences and industrial buildings. Some complete building failures.

Hurricane damage can come from flying debris impacting a building or a person, collapse of lightweight buildings, wind and rain entering buildings through broken windows and doors, and loss of roof systems caused by high speed winds passing over the structure.

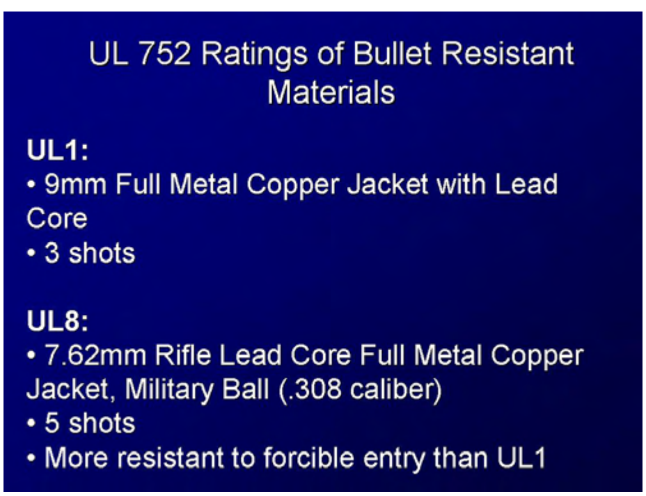
Ballistic Effects

Ballistic resistant glazing is designed to resist bullets. They are used in areas requiring protection, for instance, federal courthouses. These windows are generally not installed in every window opening in a particular building. The location of ballistic windows in a particular building will depend on the position of the threat (line of sight) and the asset being protected.



Ballistic resistant windows generally contain all glass laminates or a combination of polycarbonate or Lexan material as well as layers of glass. The polycarbonate is more effective than glass of the same thickness at stopping larger ballistic threats. The combination of thick polycarbonate and glass layers makes ballistic resistant windows difficult for firefighters to break.

There are varied "levels" of ballistic resistant windows, most often based on the bullet caliber, velocity and number of shots a single window may resist. For ballistics, the higher the caliber and the higher the velocity, the higher the energy imparted to the window system. Protection from this higher energy translates to thicker and more robust window systems. Note that the window frames and supporting walls must be able to resist the same ballistic threat as the window glass. There are several rating scales, but the most common are the Underwriters Laboratory (UL) 752 and the National Institute of Justice (NIJ) ballistic levels.



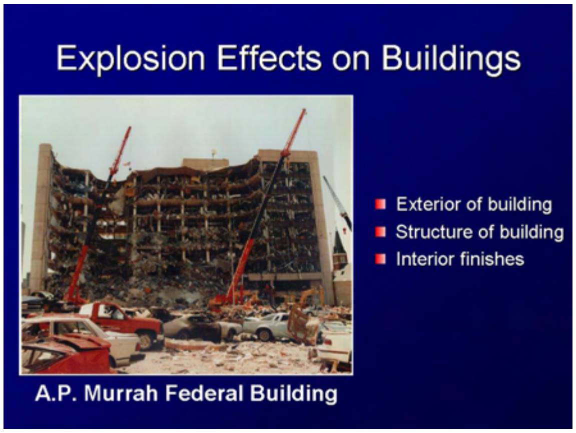
The UL 752 Ballistic rating scale has varying levels of bullet resistance. The lowest is referred to as UL Level 1 and the highest as UL Level 8.

The NIJ rating scale also has varying levels with Armor Type I being the lowest and Armor type IV being the highest.

There is no direct correlation between the NIJ and UL 752 ballistic levels. Both systems are used prominently today and can provide varying levels of protection against ballistic attack.

Explosion Effects

An explosion is an extremely rapid release of energy in the form of light, heat, and sound, which produces a shock wave. The shock wave consists of highly compressed air traveling radially outward from the source at supersonic velocities. This shock wave generates pressure loadings on the buildings and window systems. Blast loads are generally very short in duration with very high pressures. In contrast, hurricane wind loads are very long duration loads with lower pressures.



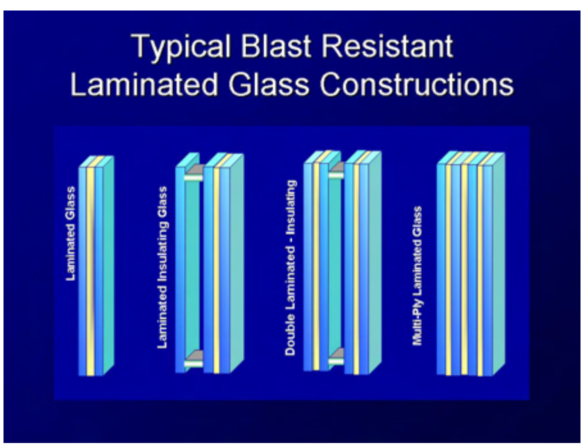
This video shows an explosive detonation. You can see the shock wave along the mountain line expanding radially outward.

Here you can see the air blast strike the structure. As a result, the pulse reflects off the face.

Actual bombing events have shown that the hazards posed by windows and glazed surfaces can be significant. In response to such events, facilities have embarked on a program to assess and evaluate its inventory to understand the vulnerabilities and to improve their resistance to attacks should they occur. Retrofits to existing windows that protect occupants from glass fragments generated in a bombing will also provide hazard mitigation for high winds.

The primary objective is to reduce the risk posed by flying glass and debris produced as window systems fail under explosively-induced blast loads. The highest goal is to reduce the risk to employees and visitors to the facility. A secondary goal is to reduce the damage to and loss of property and facilities.

These are the types of injuries from glass and glazing. In the bombing in Nairobi in 1998, there were about 5,000 people injured from debris with the majority of the injuries to the eye (ocular injuries). Approximately 90 people were permanently blinded.



A typical blast resistant window is generally made of thick layers of laminated glass or laminate glass polycarbonate systems.

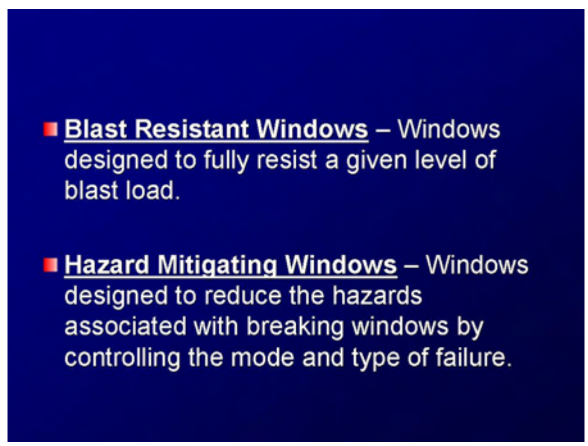
Like hurricane and ballistic resistant windows, blast resistant windows can be difficult for firefighters to break.

Window frame systems and anchorage to the structure are generally very robust and will be very difficult for firefighters to break or remove.

Because of the large numbers of explosive charge sizes and location, blast resistant windows systems can vary significantly from building to building and even floor to floor.

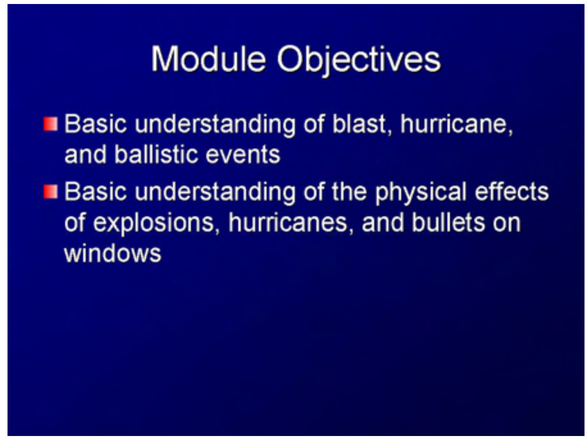
This is an example of protective glazing in action. A Rocket Propelled Grenade (RPG) attack on the al Rasheed Hotel resulted in this damage. This was a direct attack that only utilized a few pounds of TNT. The laminated glass did well, but usually protective glazing is not meant for direct attacks.

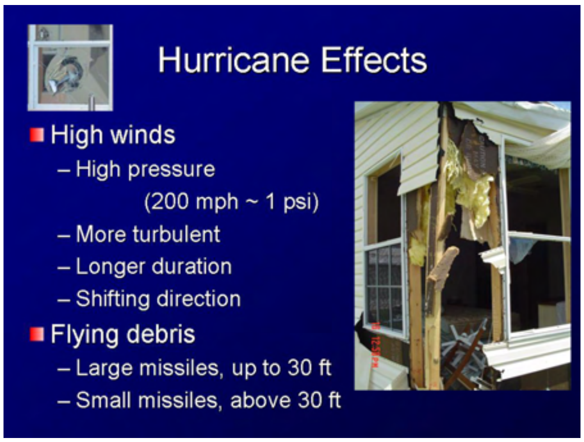
Blast resistant windows are designed to fully resist a given level of blast load. There are also hazard mitigating windows, which are designed to reduce the hazards associated with the breaking windows by controlling the mode and type of failure. For the purpose of this tutorial, we will group hazard mitigating windows with blast resistant windows.



Summary

In review, this section presented information on blast, ballistic and hurricane effects on windows to provide a basis for understanding the particular difficulties associated with forcible entry through security windows.





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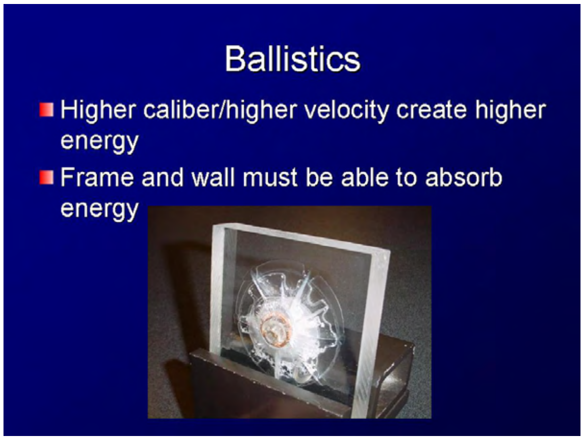
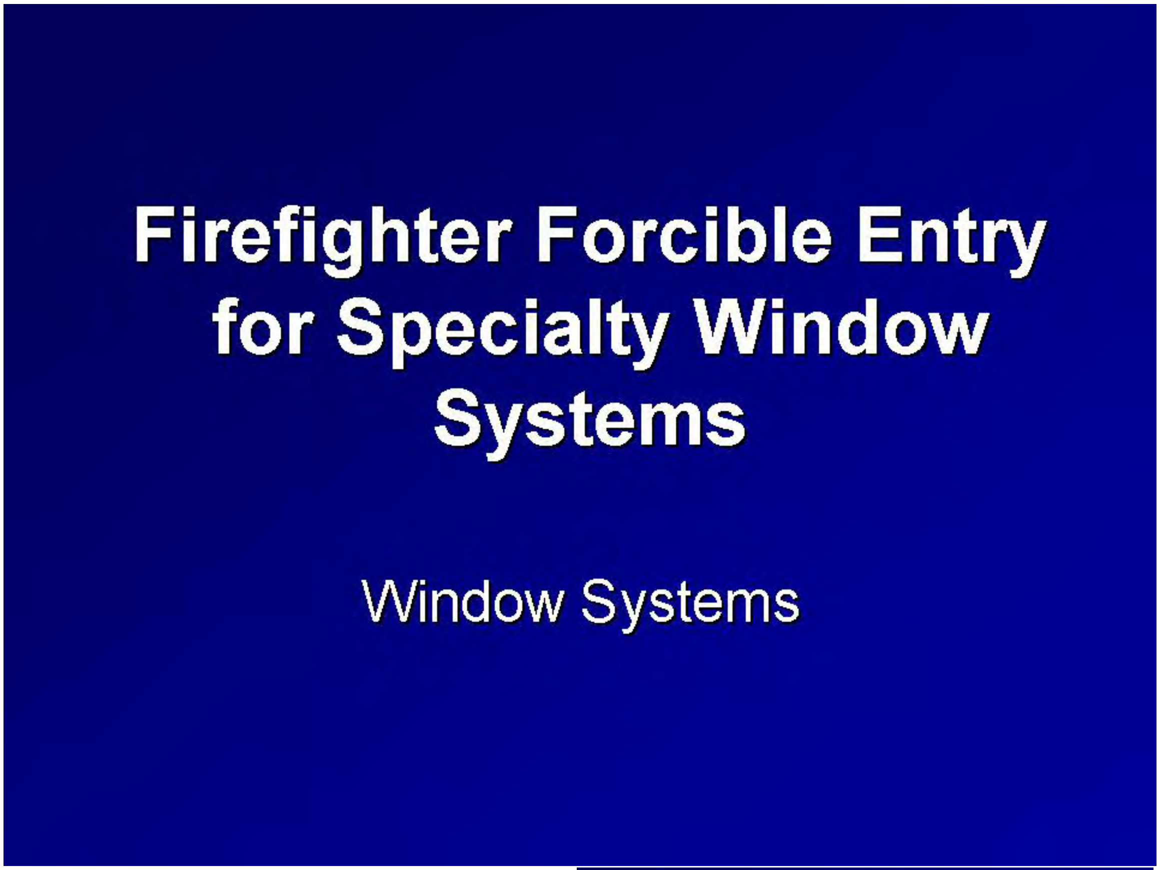
Ballistic resistant glazing is designed to resist bullets. They are used in areas requiring protection, for instance, federal courthouses. Ballistic resistant windows generally contain all glass laminates or a combination of polycarbonate or Lexan material as well as layers of glass. The combination of thick polycarbonate and glass layers makes ballistic resistant windows difficult for firefighters to break.



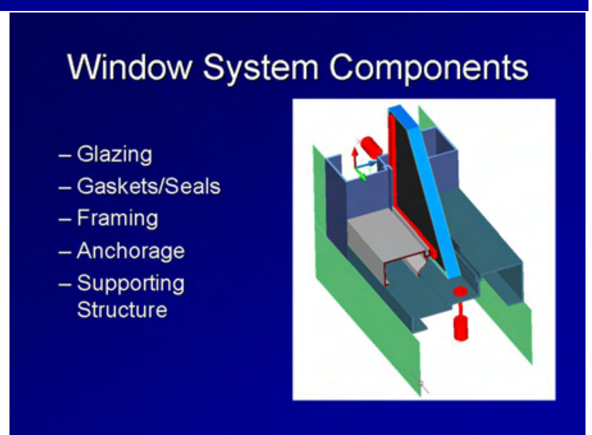
An explosion is an extremely rapid release of energy in the form of light, heat, and sound, which produces a shock wave.

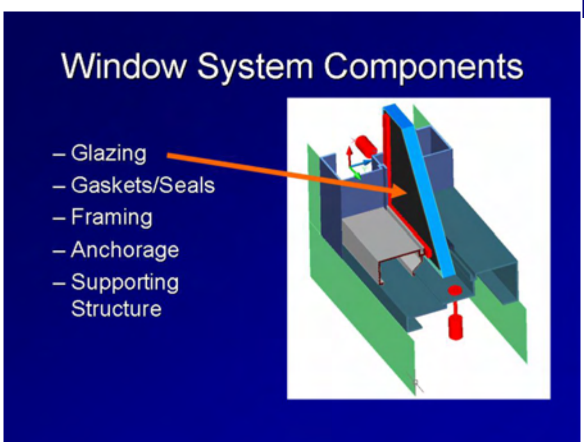
Actual bombing events have shown that the hazards posed by windows and glazed surfaces can be significant. Retrofits to existing windows will protect occupants from glass fragments generated in a bombing.



Introduction

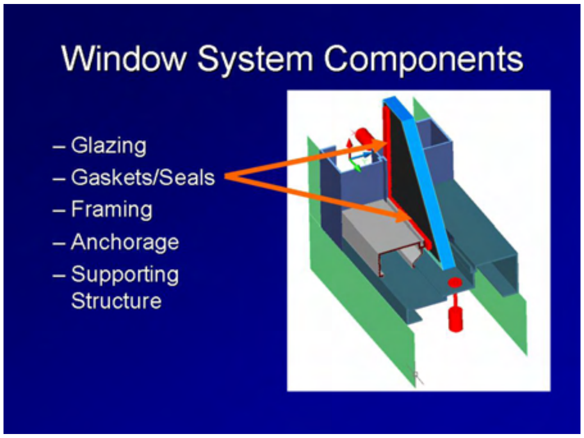
Most people think of windows as glass. However, windows must be thought of as systems. Window systems are generally composed of the glazing, gaskets and seals, framing, anchorage, and supporting structure.

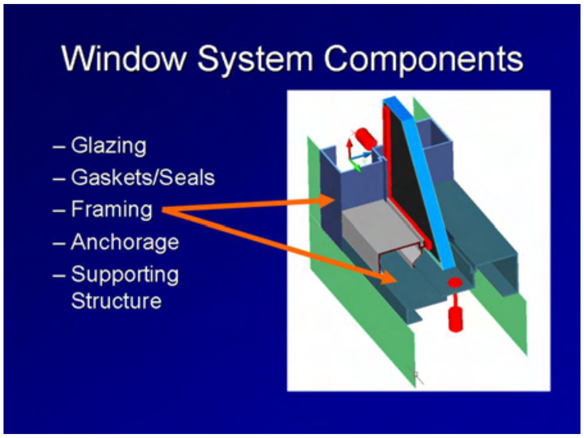




The glazing can be glass, but may also be composed of other materials.

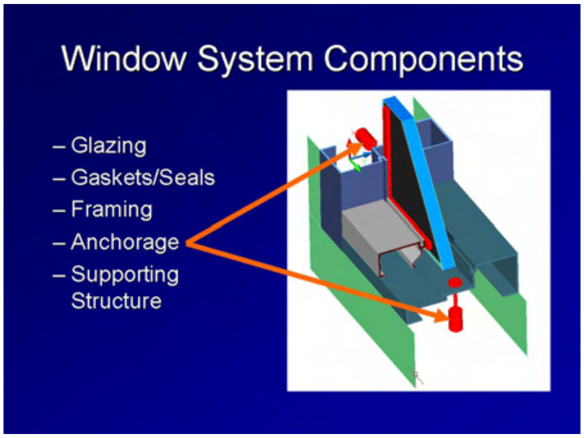
The glazing is supported in the frame by the gaskets and seals.

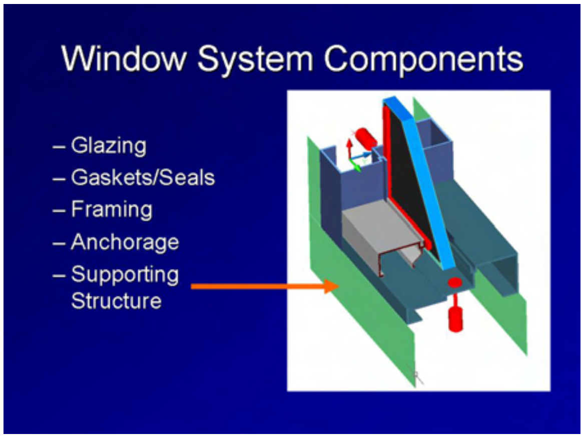




The framing may be metal or wooden. It is the component of the system that holds the glazing and sealants.

The anchorage is the component that attaches the frame to the wall or supporting structure.





The supporting structure is the wall system which may be wood, brick, steel, or various other materials.

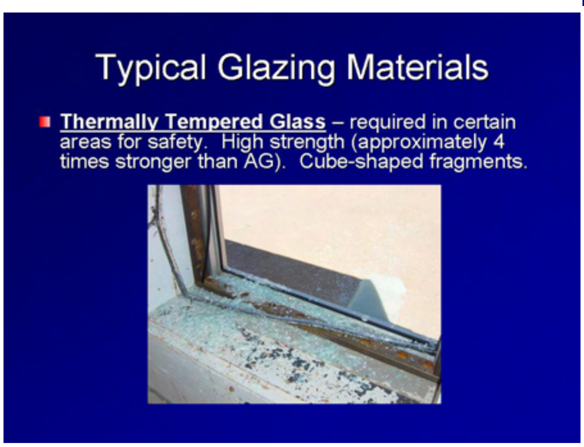
Glazing Types

Glazing is the material used within the frame. It is normally transparent glass but may be translucent, fritted, opaque, or solid (non-light transmitting).

Typical Materials include:
annealed glass, heat strengthened glass, fully tempered glass, and polycarbonate.

Annealed glass is the most common type of glazing. It is also known as float or plate glass. This type of glazing fails in hazardous, dagger-like fragments.

Heat Strengthened glass is partially tempered glass. This type of glazing is approximately two times stronger than annealed glass. Heat strengthened glass also fails in hazardous, dagger-like fragments.

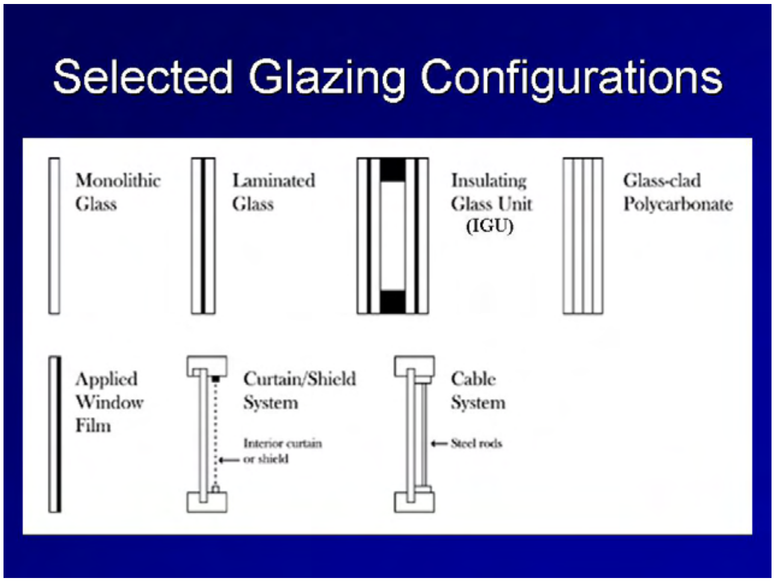


Thermally Tempered glass is required in some areas for safety. This glass is approximately four times stronger than annealed glass. This type of glazing fails in cube-shaped fragments.

Polycarbonate is a plastic-like material. It is not composed of glass. This type of glazing does not form shards. The material is significantly more flexible than glass. Polycarbonate windows generally fail due to bite failure in systems without a sufficiently large frame bite.

Glazing Configurations

Glazing may be monolithic or laminated. Monolithic glazing is composed of one layer in one pane. Laminated glazing is composed of multiple layers in one pane. Each layer may be composed of different materials.



Insulating glass units (IGUs) are glass systems which have two or three panes of glass separated by an air gap. The glazing in IGUs may be composed of monolithic or laminated glazing types.

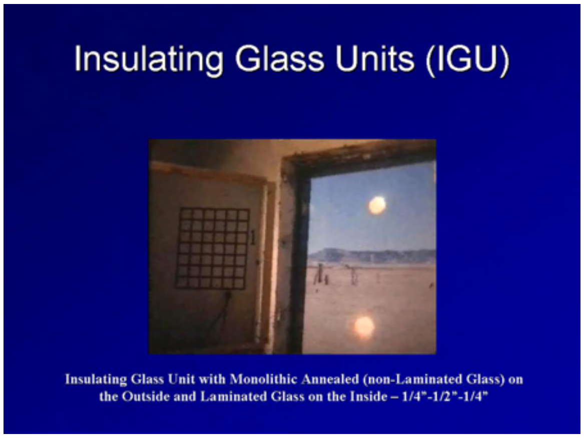
Glass-clad Polycarbonate is polycarbonate with glass surrounding it to prevent scratches and reactions with sealants.

Some window systems have applied window film installed on the interior surface of the glazing. Security film is specially manufactured and designed to remain adhered to glass shards in the event of an explosive detonation. The film helps reduce the potential of penetrating glass shard injuries to building occupants.

Window systems may also have secondary catcher systems such as blast curtain/blast shield systems and cable or rod systems designed to limit the amount of glazing that enters the facility if the glazing fails.

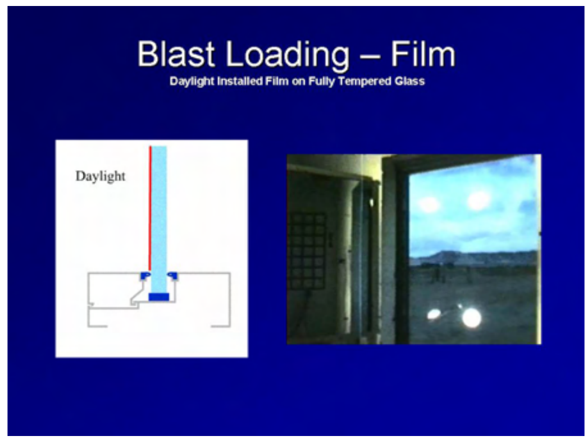
Laminated glazing, often referred to as safety glass, consists of multiple layers of glazing bonded together with an interlayer usually made of polyvinyl butyral (PVB). Failure modes of laminated glazing in a blast situation tend to be less hazardous than monolithic glazing.

This laminated window was sealed with structural silicone sealant at the interior side of the window to glue the pane in place. In other words, it was wet glazed. The window begins to detach, but does not completely separate from the frame.



Insulating glass units (IGUs) are systems which have two or three panes of glazing separated by an air gap.

This IGU is composed of a monolithic annealed pane on the outside and a laminated pane on the inside of the facility. The outer pane breaks, and the interior laminated pane catches those fragments and few fragments enter the occupied space.



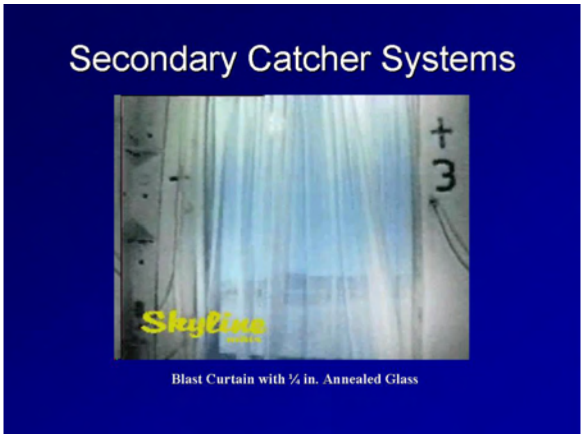
Films may be used in new construction but are more often found as retrofits to existing window systems. Films may be clear or tinted. For security films, thicknesses vary but are usually between 4 and 15 mil. Most hazard mitigating applications are 7 to 8 mil. Beyond 8 mil, the film is increasingly difficult to bend.

A daylight application of security window film is applied on the interior side of the glazing and is not applied beyond that portion of the glazing that is visible. In other words, the film is not applied within or attached to the frame.

This window system has a daylight installed film. The glazing enters the facility in one large piece instead of numerous small pieces.

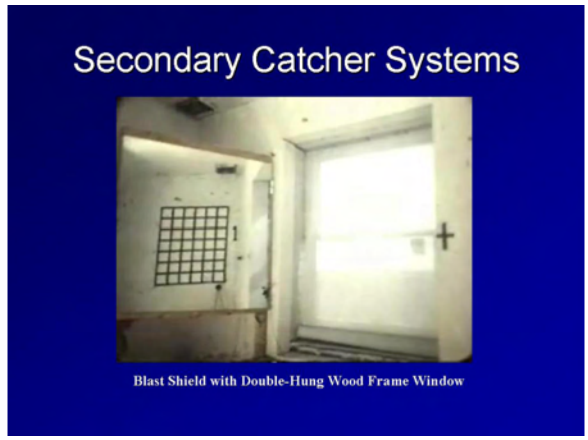
Mechanically attached film is more capable of providing protection against blast. The film is installed on the interior surface of the glazing and wrapped around a batten bar system along the edges. The film is then mechanically attached to the frame with screws. The film may be mechanically attached on one, two, or four sides.

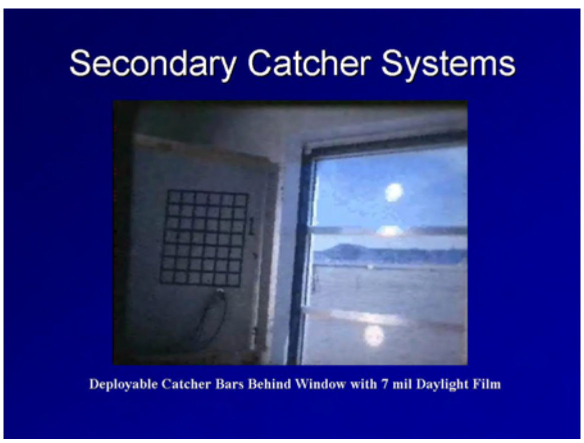
This window system has security film mechanically attached on all four sides. The film and attachment prevents the glazing from entering the occupied space.



Blast curtains are curtains made with more robust, tear-resistant materials. They are installed on the interior of the facility. The curtains are designed to catch fragments, slow them down, and contain them.

This window system has a blast shield system installed on the interior of the facility. The window fails, but the blast shield deploys and catches all of the debris.

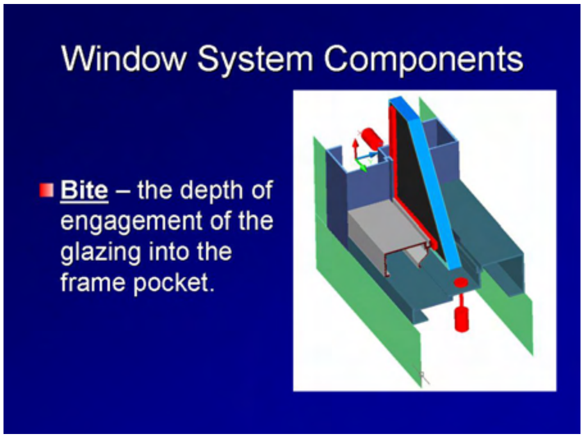


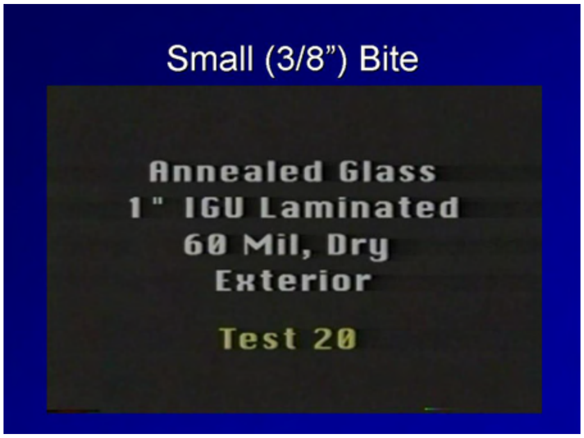


This window system has a daylight film and a catcher system. The catch cables deploy and capture the film and prevent it from coming into the occupied space.

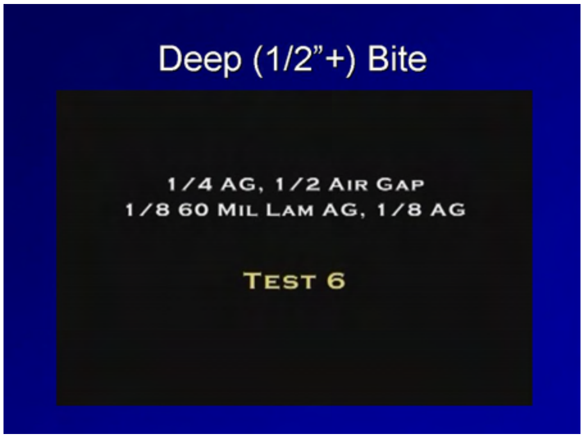
Additional Components

The frame bite is the depth of engagement of the glazing into the frame pocket. The frame bite is also sometimes referred to as rebate. In general, standard window systems have frame bites which vary from 1/4 inch to 1/2 inch. For blast resistant windows, most designs require a minimum of 1/2 inch bite.

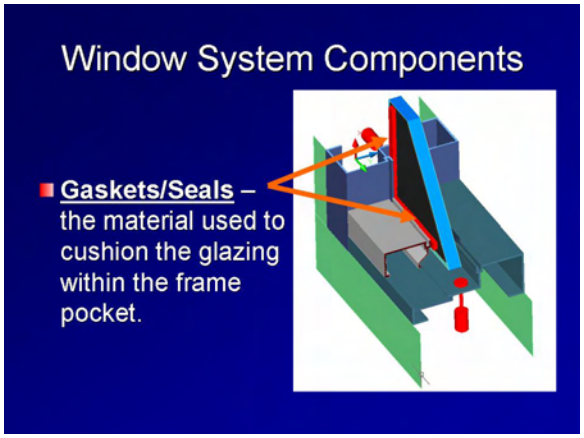




This window has a standard frame bite. The firefighter uses standard firefighting tools on the window and is able to push the glazing out of the frame.

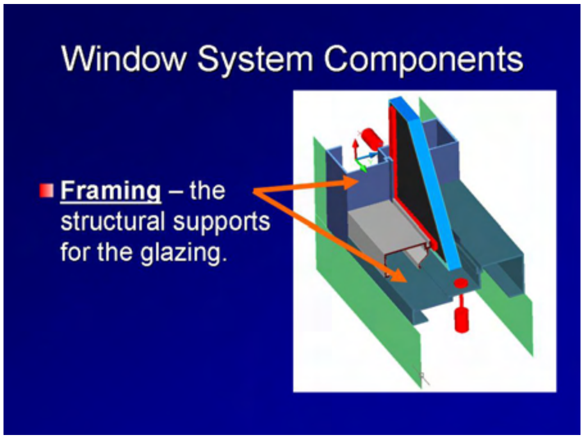


This window has a larger frame bite more typical of security windows. The large bite resists this pushing and forces the firefighter to physically chop the glazing out of the frame.

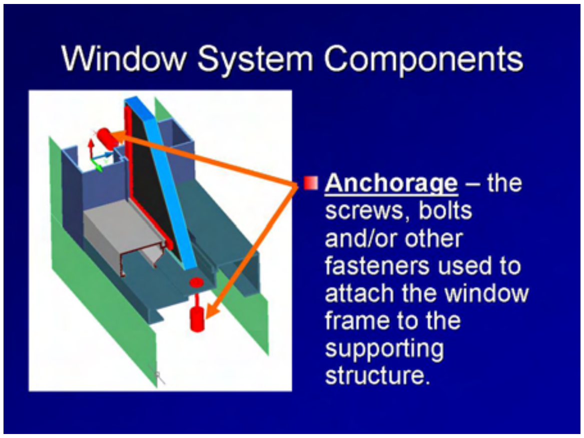


Gaskets and seals are the materials used to cushion the glazing within the frame pocket. They are also used to seal the window from air and water infiltration.

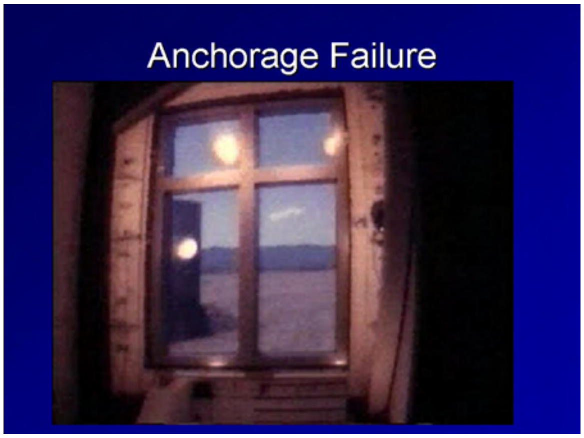
Windows may be dry glazed or wet glazed. Dry glazed window systems are sealed with a gasket, which is a precut rubber that may be pushed between the exterior glazing surface and the frame. Wet glazed window systems are sealed with a silicone sealant at the interior side of the window to bond the window glass in place.



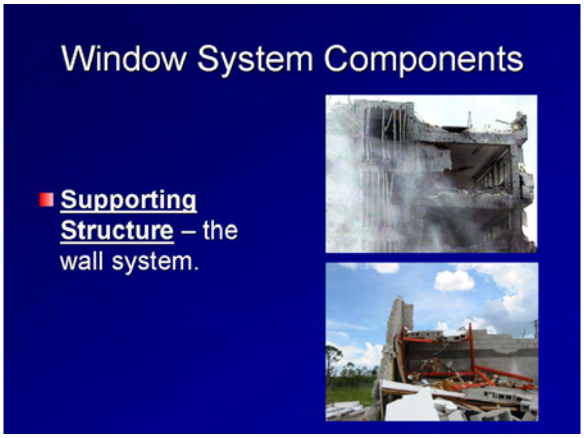
The framing provides structural support for the glazing. The framing is composed of the head, jambs and sill. In window systems designed for blast, hurricane, or ballistics resistance, the frame serves to capture the glazing at the edges and to transfer loads from the glazing to the supporting wall.



The anchorage is composed of the screws, bolts and/or other fasteners used to attach the window frame to the supporting structure.

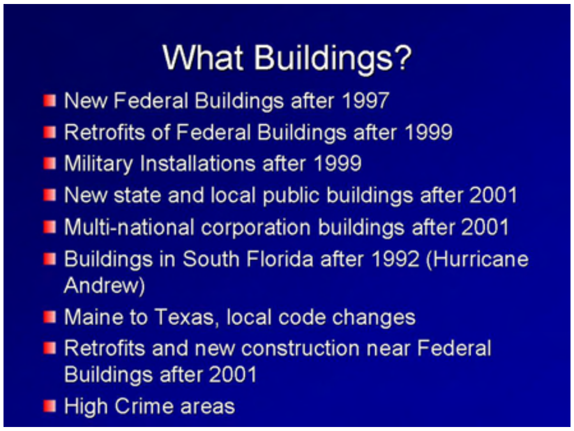


In this blast test, the glazing stayed intact and the framing stayed intact. However, the anchorage failed. The 400 lb window system enters the occupied space. The system was not appropriately designed. The anchorage should be as strong or stronger than the glazing and frame.



The supporting structure is the wall system. The wall may consist of wood, steel, aluminum, brick, tile, concrete, etc. The wall must be able to support the window system through its anchorage.

One of the concerns with providing forcible entry information to a wide audience is security, especially when discussing a specific building's windows. Information concerning these window systems is not generally transmitted to local fire departments.



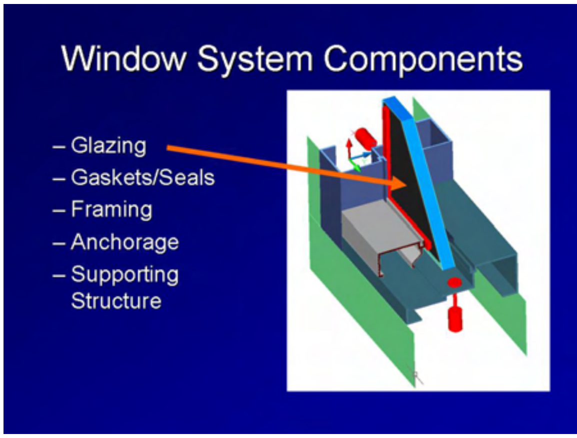
Here is a partial list of some buildings which may have security windows. For federal buildings, the General Services Administration (GSA) has required security windows for new construction and window retrofits to buildings with certain occupancies.

Polycarbonate-only glazing windows (a type of security window system) can also be found in schools.

Hurricane resistant window systems are becoming a typical requirement for new window systems in coastal regions on the east coast and in Hawaii.

Secure buildings no longer look like fortresses, and it is sometimes hard to distinguish them from standard buildings.

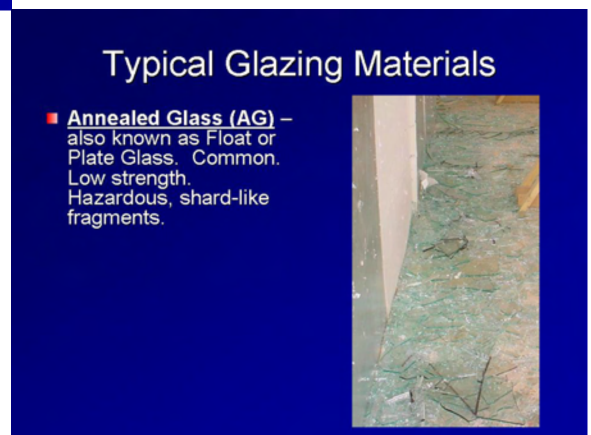
Summary

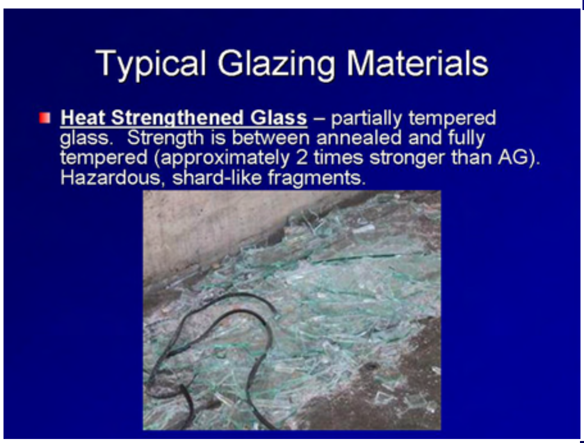


Window systems are generally composed of the glazing, gaskets and seals, framing, anchorage, and supporting structure.

The glazing can be glass but may also be composed of other materials. The most common glazing types are annealed glass, heat strengthened glass, thermally tempered glass, and polycarbonate.

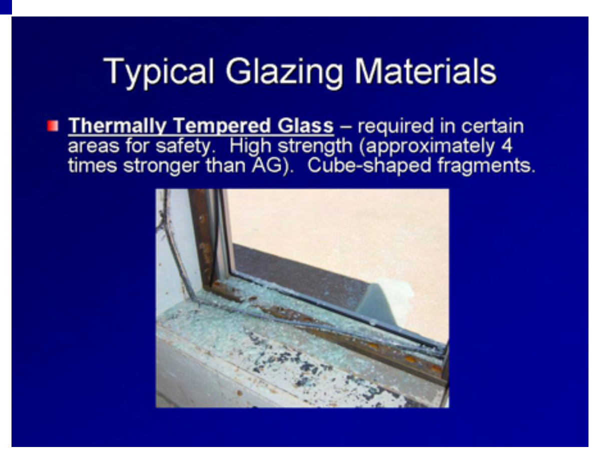
Annealed glass fails in large dagger-like fragments.



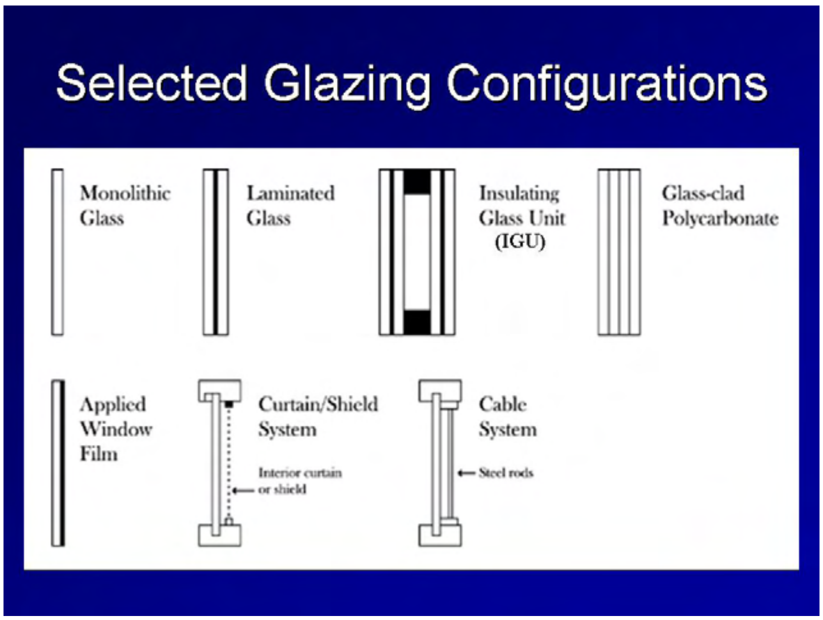


Heat strengthened glass also fails in dagger-like fragments but is twice as strong as annealed glass.

Thermally tempered glass fails in small cube-shaped fragments and is four times as strong as annealed glass.



Polycarbonate is more flexible and does not fail in shards.

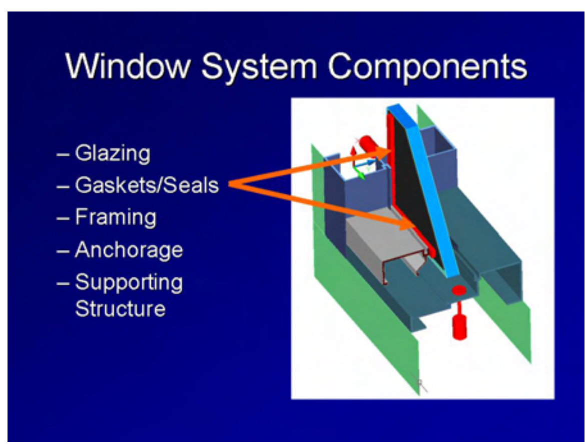


Monolithic glazing is composed of one layer in one pane. Laminated glazing, often referred to as safety glass, consists of multiple layers of glazing bonded together with an interlayer.

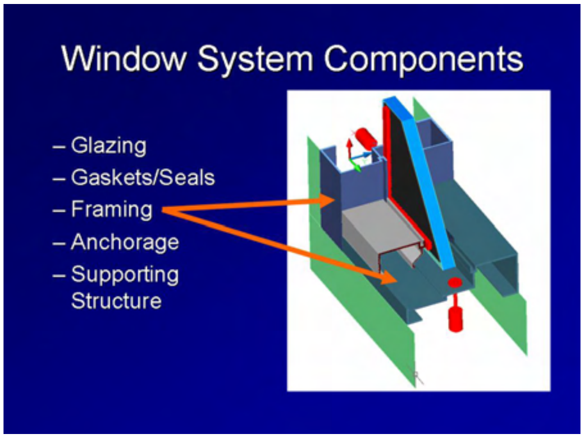
Insulating Glass Units (IGUs) are glass systems which have two or three panes of glazing separated by an air gap.

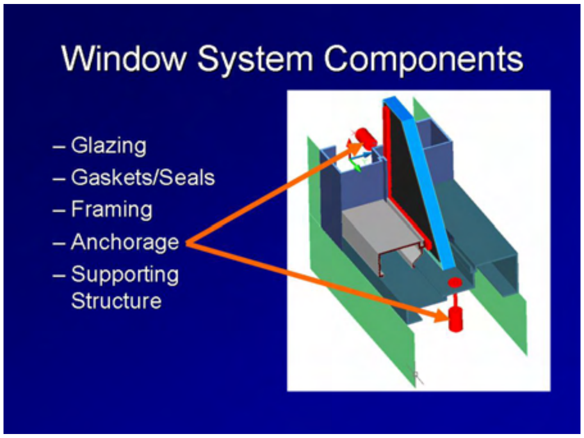
Some window systems have applied window film installed on the interior surface of the glazing. For security film, thicknesses vary but are usually between 4 and 15 mil. Secondary catcher systems such as blast curtains or cable systems may be installed on window systems.

Gaskets and seals are a significant component of a window system. They are used to prevent air and water infiltration.



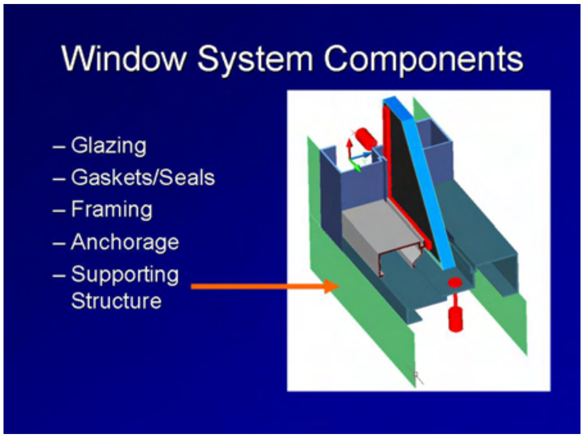
The framing may be metal or wooden. It is the component of the system that holds the glazing and sealants.

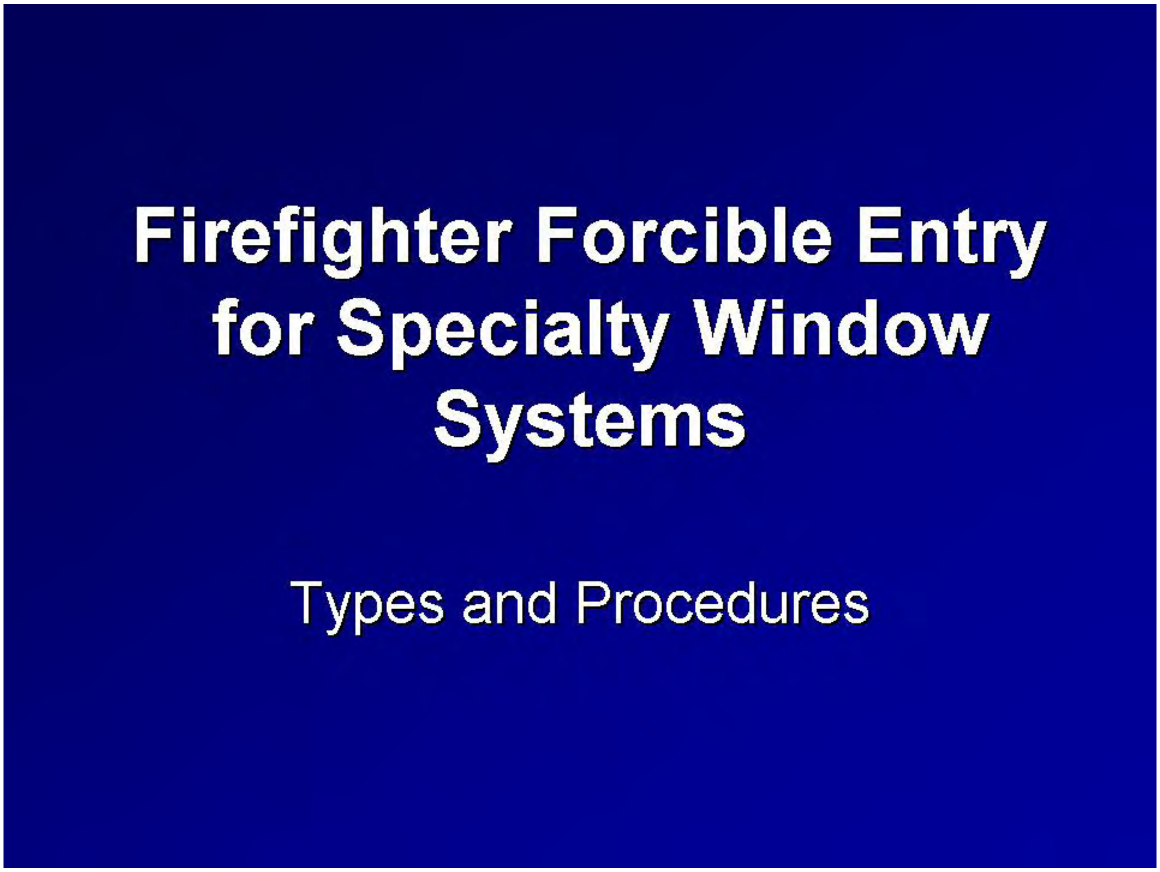




The anchorage is the component that attaches the frame to the wall or supporting structure.

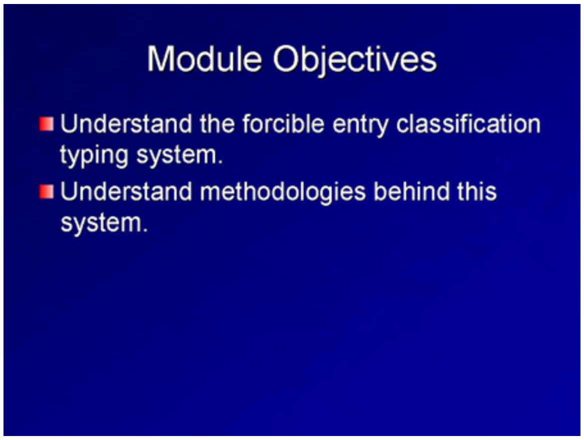
The supporting structure is the wall system which may be wood, brick, steel, or various other materials.





Introduction

The objective of this section is two-fold: first to present a forcible entry classification typing system for windows and second to share the methodologies found to be most effective for forcible entry and emergency escape through these types.



The International Fire Service Training Association (IFSTA) is recognized nationally as one of the main sources for fire training and procedures manuals. IFSTA publishes several guidelines, including those for forcible entry of windows. This study uses these IFSTA guidelines as a basis of comparison for forcible entry procedures.

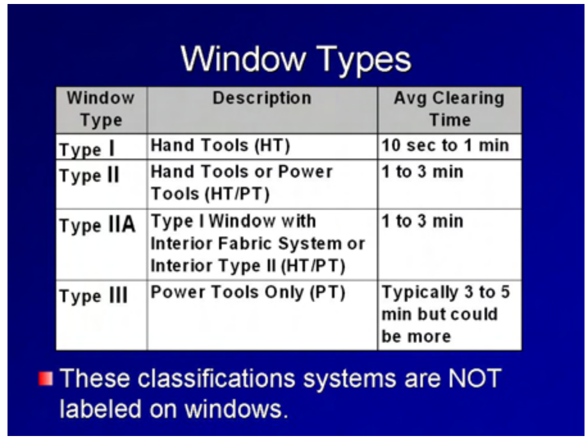
Window ventilation guidelines can be found in the IFSTA *Fire Service Ventilation 7th Edition*. The guidelines are as follows:

- First the firefighter should check if the window is unlocked.
- If the window is locked the firefighter should then break the window using a tool.
- The firefighter should be in full protective clothing, including hand and eye protection and should also be upwind of the window.
- The tool handle should be held higher than the blade to prevent glass from sliding down the handle.
- When working above ground, windows should be broken inward whenever possible in order to avoid a flying shard hazard to those working below.

Currently IFSTA has no guidelines for the forcible entry of laminated glass or glass-clad polycarbonate window systems.

Over the course of this research project, 3 different fire departments were involved in testing different types of security windows. As a part of this project, the data from these demonstrations have been reviewed to develop a forcible entry classification typing system. The intent of this classification system is to create a limited number of window categories, which are based on firefighter forcible entry procedures, tools, and time to clear the window. This will allow firefighters to be better prepared when they encounter these windows.

The classification system divides security windows into three basic types (with one additional subtype), based on the tools and effort required for firefighters to exit or enter the windows. The following sections describe the forcible entry through these types of windows.


Window Types

Window Type	Description	Avg Clearing Time
Type I	Hand Tools (HT)	10 sec to 1 min
Type II	Hand Tools or Power Tools (HT/PT)	1 to 3 min
Type IIA	Type I Window with Interior Fabric System or Interior Type II (HT/PT)	1 to 3 min
Type III	Power Tools Only (PT)	Typically 3 to 5 min but could be more

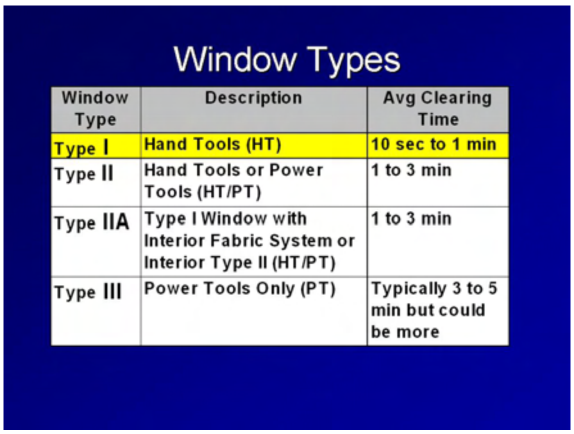
- These classifications systems are NOT labeled on windows.

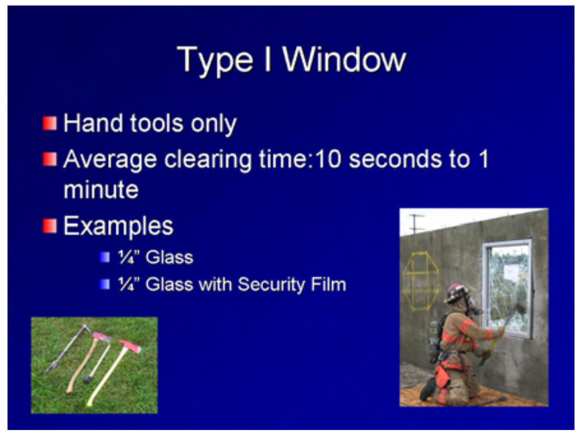
Currently, there are no plans to physically label windows by this classification in part so that the security of the building is not compromised. During pre-fire planning, local fire departments should work with the building owners to gather more in-depth information on their window systems.

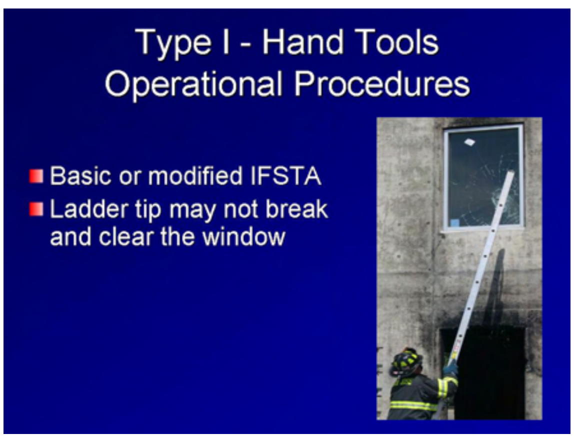
Type I Windows

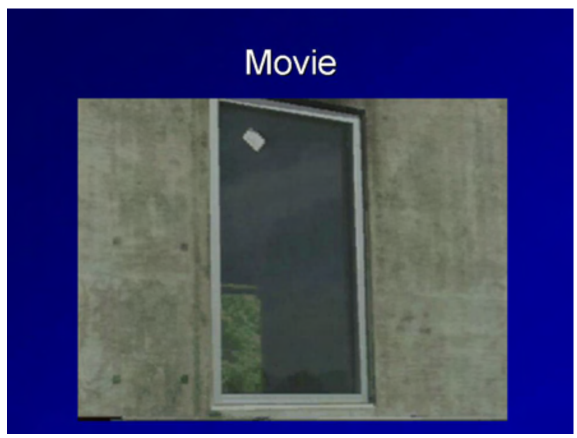
Type I windows require only hand tools. The average time to clear the entire window opening varies from 10 seconds to 1 minute. Type I windows present minimal resistance to firefighter forcible entry. Standard firefighting tools and materials are adequate for forcible entry using IFSTA recommended techniques. Some examples of Type I windows include 1/4 inch glass and 1/4 inch glass with security film.

Some operating procedures such as breaking second floor windows with a ladder tip, may no longer be effective for some Type I windows.

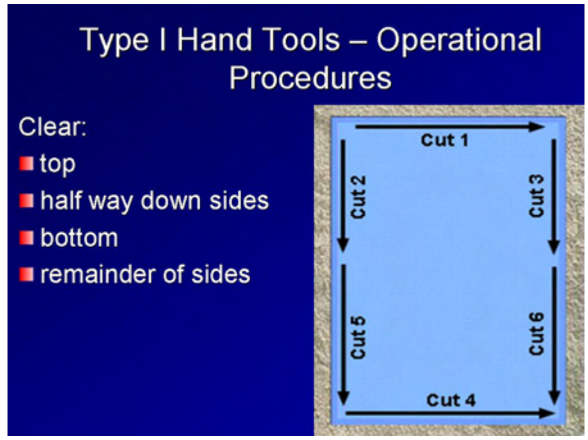






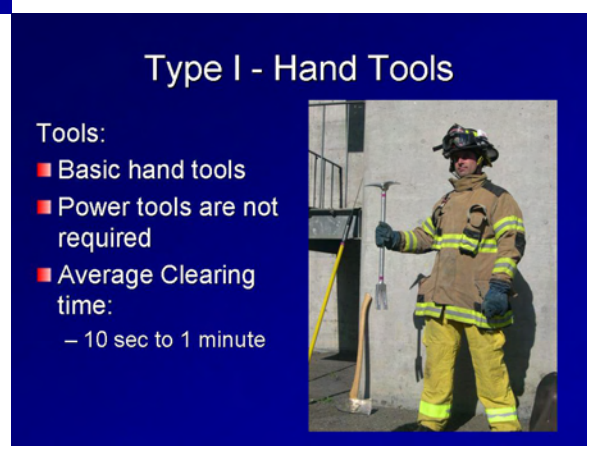


The best technique employed over the course of the testing was to clear the top, clear halfway down the two sides, then the bottom, followed by the remainder of the sides. When using hand tools this procedure allowed for more rapid venting and then complete clearing of the opening. To vent: execute cuts 1, 2 and 3 as shown. To clear the opening: complete cuts 4, 5 and 6. The bottom is cleared prior to the final cut because it is difficult to make the bottom cut if it is last.



Some Type I windows may have a film which tends to keep the glass shards together and provides a safety benefit to firefighter operations because they have a film applied at the interior face. Glass on IGU windows would hold together on the inner pane only, the outer pane would break as a typical window.

Basic hand tools are adequate, and power tools are not required. The times to clear the entire window opening varied from 10 seconds to 1 minute.

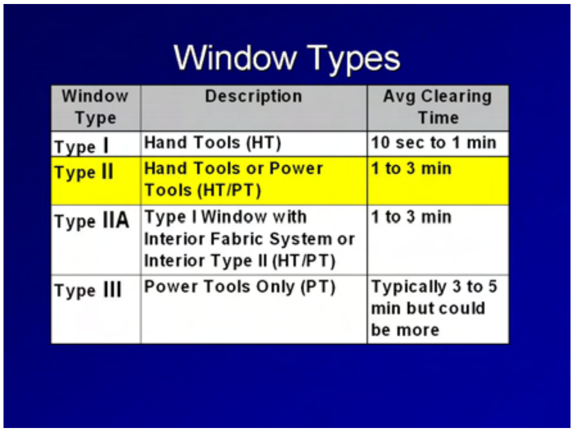


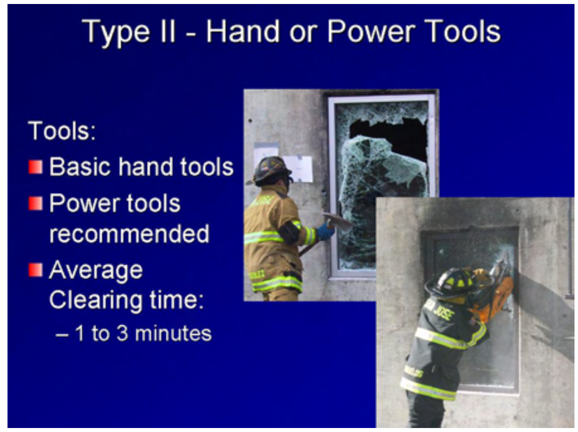
Type I Demo

This video is from the classroom training.

Type II Windows

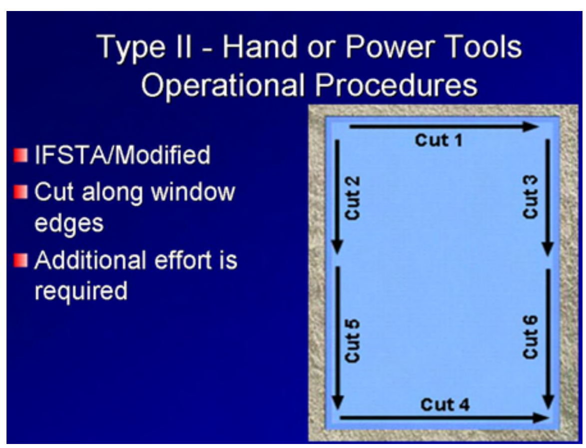
Type II windows call for either hand tools or power tools. Type II windows present much greater resistance to firefighter forcible entry than Type I windows. Clear times typically range from 1 to 3 minutes, representing a significant increase over clear time of Type I windows.





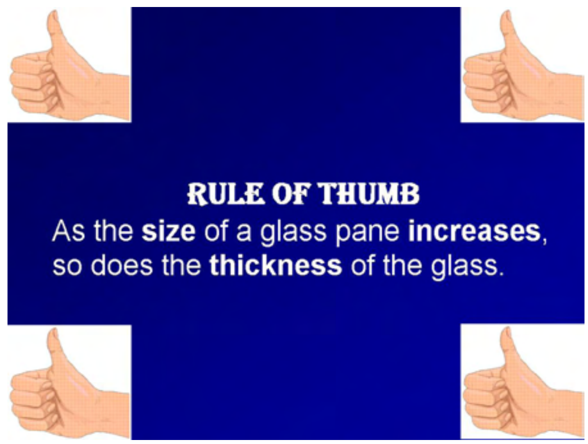
Standard firefighting hand tools are still adequate for forcible entry, but power tools may be the best method.

Like Type I windows, all Type II windows require that the glass be chopped or cut around the perimeter in order to remove it from the window opening.



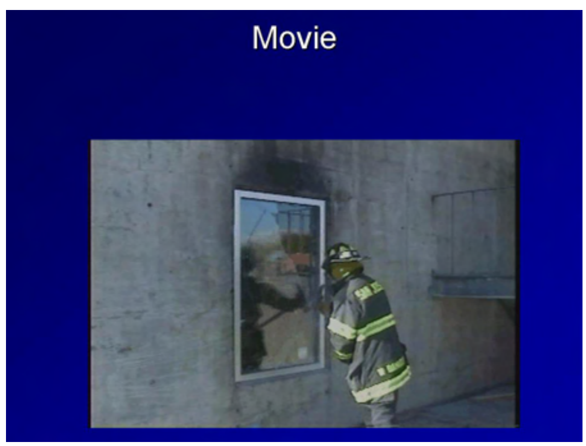
Chain saws, circular saws and reciprocating saws all worked well on the lower range of the Type II windows. Reciprocating saws were not effective on thicker glass in these windows. For this reason, battery powered reciprocating saws will be categorized with hands tools for this tutorial.

As a rule of thumb, as the overall size of a glass pane increases, so does the thickness of the glass.



Carbide tipped blades that use randomly placed carbide chips on circular saws were most effective as were carbide tipped chains for the chain saws.

For IGU Type II windows the outer pane of glass may break relatively easily, but the inner pane will require significantly more effort.



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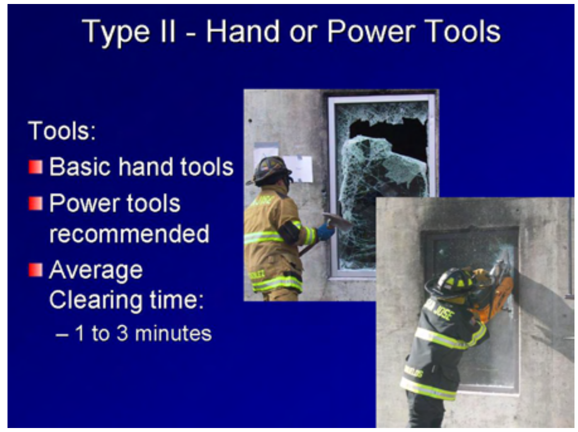
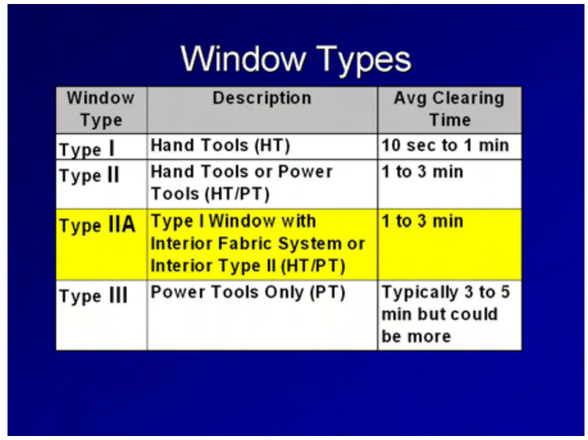


Type II Demo

This video is from the classroom training.

Type IIA Windows

Type IIA windows are Type I windows on the exterior side of a building with a secondary system on the interior. The secondary system for example, could be a Type II window or an interior catch system. The average clear time on these windows is 1 to 3 minutes, but it depends on the tools that you choose.



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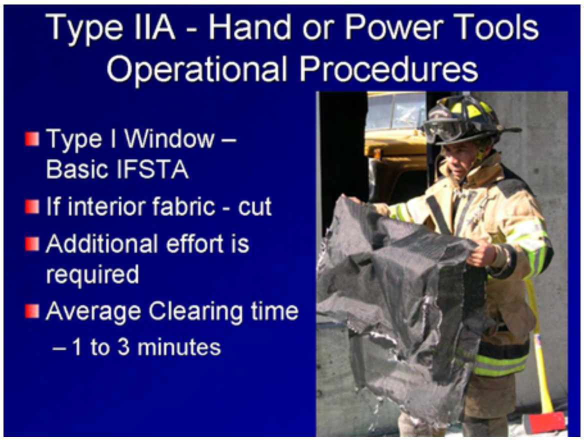
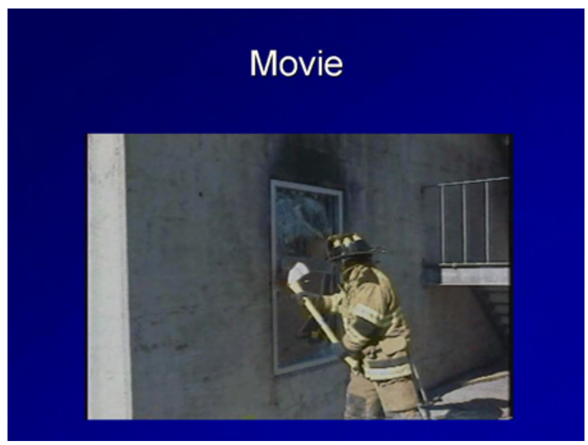
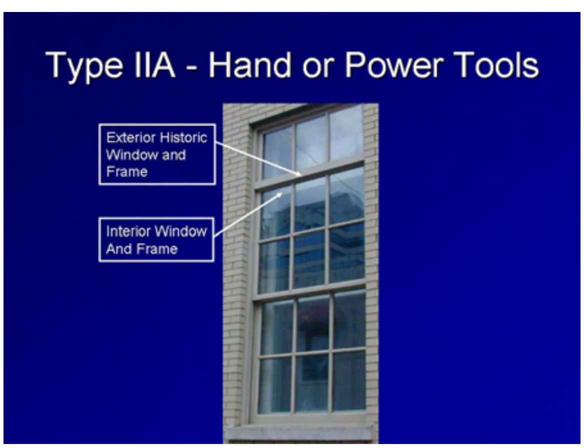


Firefighters encountering this window type will need to first break the outer Type I window then enter the interior system. The outer window can be broken using IFSTA or modified IFSTA techniques, but the inner system will be more problematic.

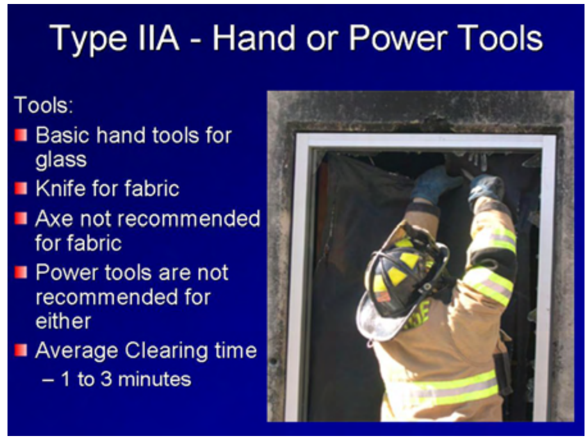
The most common catch system is fabric such as an attached curtain. If the inner system is a catch system made from fabric, the firefighter should use a serrated knife to cut through the cloth. Trauma shears and axes were also used on the fabric and were found to be less than ideal tools for the task. If the system is not fabric then the firefighter may need other tools.





This window type often occurs at historic buildings which have been retrofitted for security purposes.

Type IIA windows are Type I windows on the exterior side of a building with a secondary system on the interior. The average clear time on these windows is 1 to 3 minutes, but it depends on the tools that you choose.

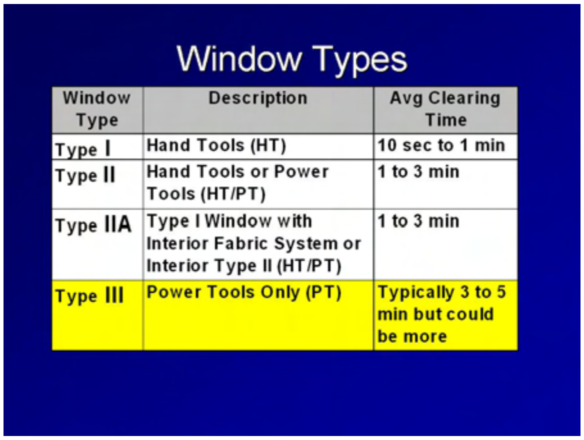


Type IIA Demo

This video is from the classroom training.

Type III Windows

Type III windows require the use of power tools for forcible entry. Clear and vent times will be dependent on the window and tools used but are typically up to 5 minutes or more. When encountering a type III window, firefighters should wear their self contained breathing apparatus (SCBA) to protect against the glass dust.



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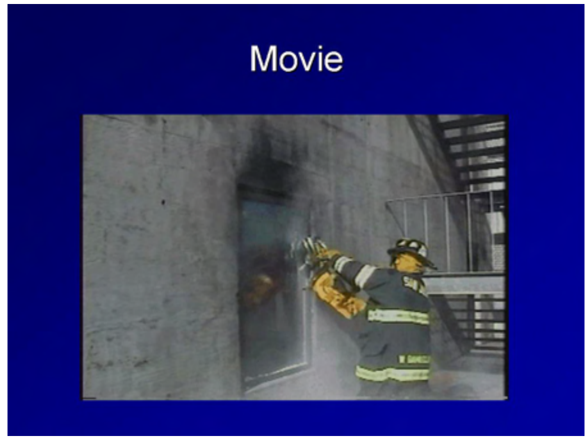
Type III	Power Tools Only (PT)	Typically 3 to 5 min but could be more

These window systems may have a monolithic pane of glass at the exterior, but the inner panes of glass are extremely resistant.

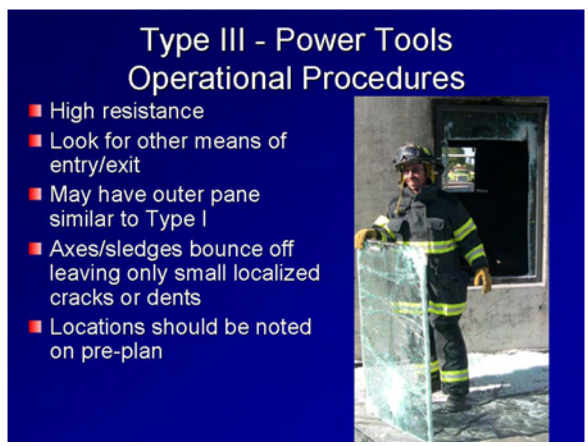
Hand tools such as axes and sledge hammers will have no effect other than fatigue for the firefighters.

These videos show different tools used against these window systems during the demonstrations and training classes.



Standard hand tools, CO2 extinguisher, and circular saws with different blades were all used. The CO2 extinguisher was not found to be effective. The most effective tool was the circular saw with a carbide tipped blade.

Type III windows require the use of power tools for forcible entry. Clear and vent times will be dependent on the window and tools used but are typically up to 5 minutes or more. Alternate locations for forcible entry or emergency escape are highly recommended. Emergency escape is only possible with the use of power tools. During pre-fire planning, local fire departments should work with the building owners to gather more in-depth information on their window systems.

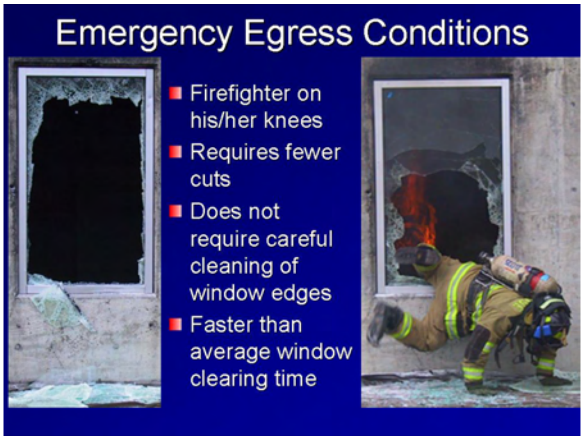


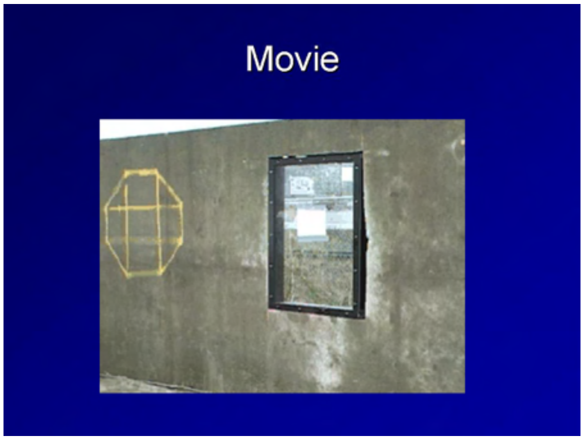
Type III Demo Part 1 and 2

This video is from the classroom training.

Emergency Conditions

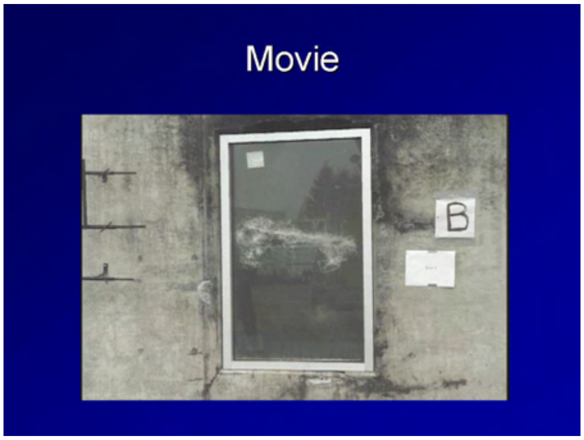
One major concern is the scenario of a firefighter mayday. Due to the increased effort required to get through these window systems, it is important to determine how they affect emergency escapes.





With the exception of Type III windows (which cannot be broken using hand tools), it was found that the emergency escape situations took less time than the forcible entry situations since the number and length of cuts required to allow a firefighter to escape are less than those required for clearing a window.

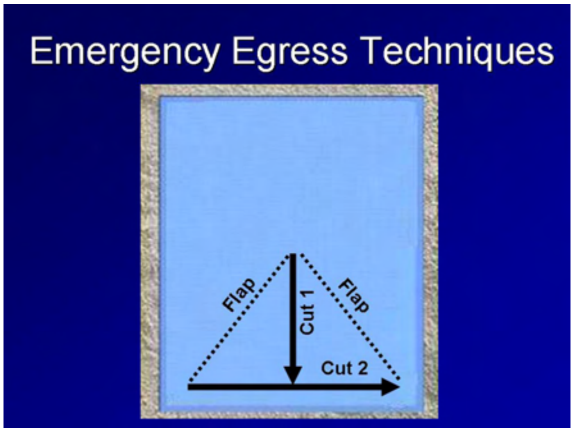
These videos show different demonstrations simulating emergency escape conditions. One clearly depicts the live burn demonstration. This video shows one of the dangers associated with these windows when exiting the building. If the outer, non-laminated pane of glass is not completely broken, it can form hazardous shards which hang over a firefighter's head, neck and back on exiting the window. This presents a significant hazard.

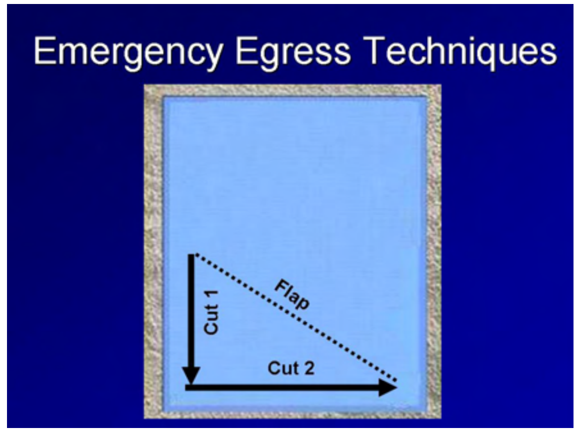


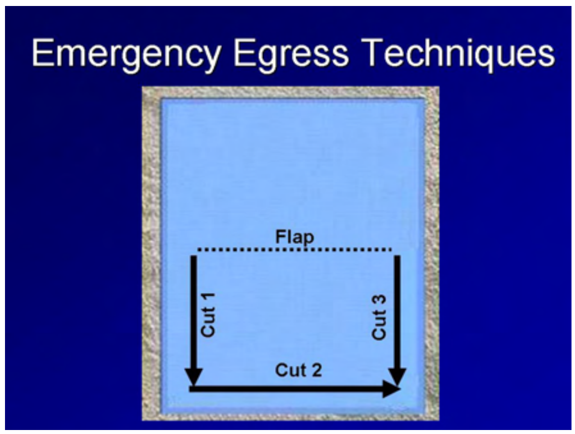
It will therefore be important for the firefighters to hit the window above the opening to break away remaining pieces of the exterior glass pane. This will decrease the likelihood of glass shards falling from above and injuring the exiting firefighter.

Even though times for the emergency escape demonstrations were shorter than those for forcible entry, they were much longer than what firefighters would have expected from standard window systems and required much more effort. Several techniques were found to keep exit time to a minimum.

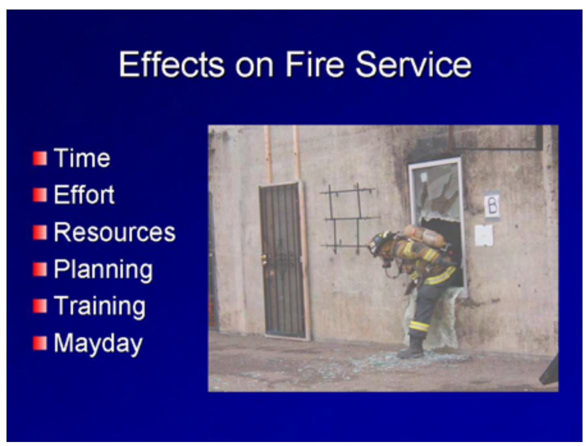
Here are the cuts associated with the three techniques: All three of these techniques create a flap above for the firefighter's body, increasing protection from potential glass shards from the outer pane of glass.







The increasing use of these specialty window systems in buildings presents challenges to the fire service. These challenges are found in typical fire-scene operations (time, effort, and resources required to deal with windows on the fire-scene), up-front efforts (pre-planning and training), and in firefighter mayday operations.



Lessons Learned

The following include information from lessons learned during the demonstrations and trainings performed in the course of this study:

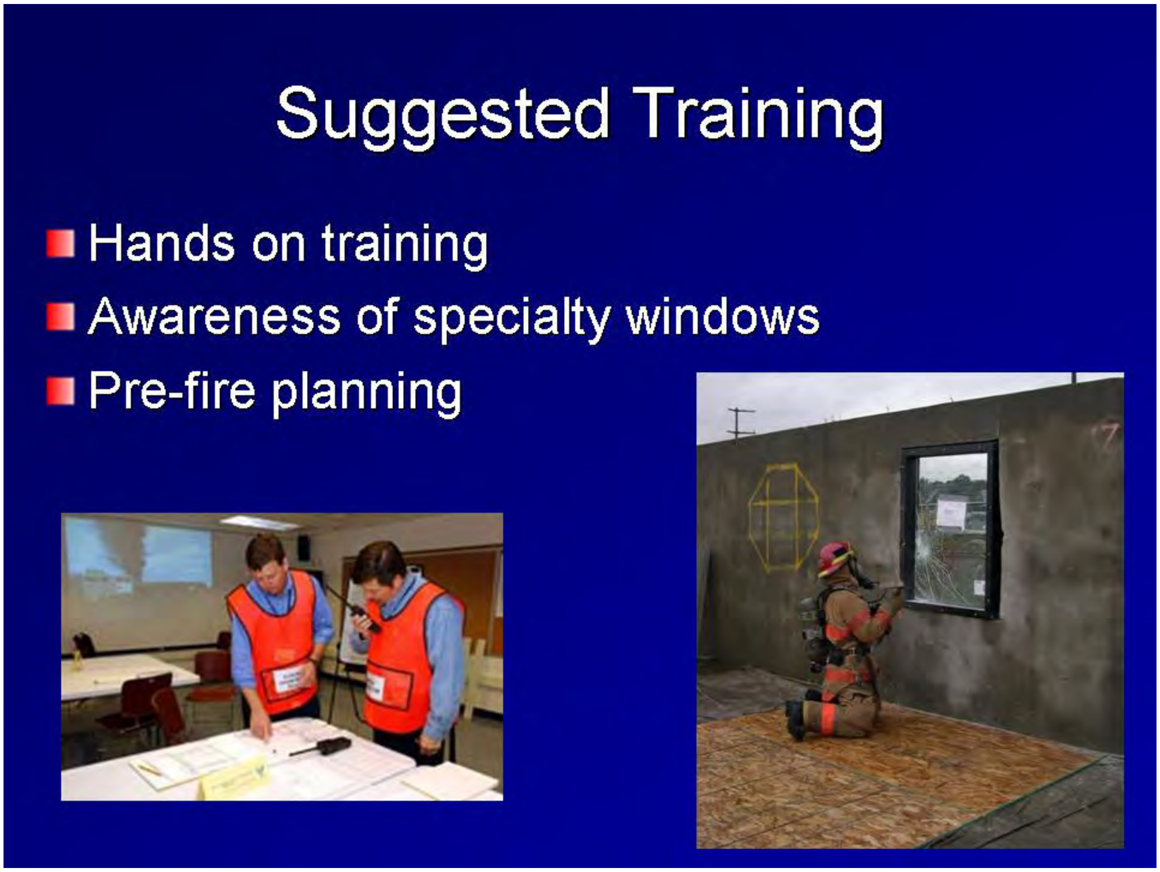
• Fire departments may want to update their standard operating procedures to reflect the growing use of security window systems and the related implications to fire operations. Possibilities may include:

o When a call comes in on a building that is known to or found to contain hurricane windows, call another alarm to ensure adequate personnel onsite.

o Ensure that all apparatus carry the appropriate power tools with the proper chains or blades.

o If a firefighter finds him/herself unable to escape through the window, he/she should radio in to relay his/her location and try to find another location to exit.

Suggested Training



• In addition to this tutorial, fire departments may want to provide hands on training regarding these window systems.

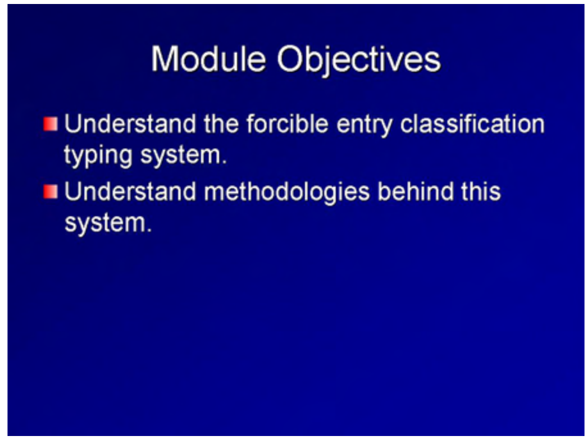
• If possible, local fire departments should work with their building owners and developers to increase awareness of specialty window design during new building permitting processes.

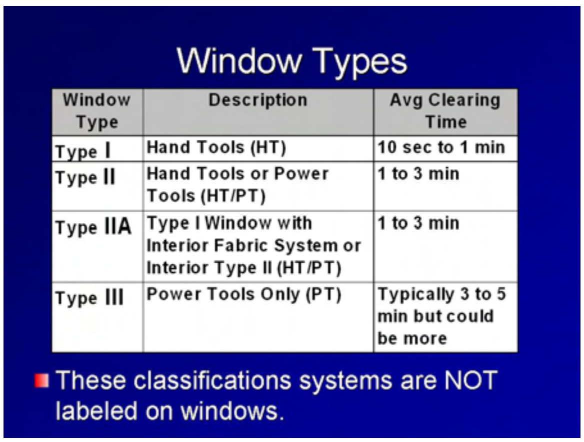
• During pre-fire planning, local fire departments should work with the building owners to gather more in-depth information on the window systems and property.

• Specialty security window systems should be included on the pre-fire plans.

Summary

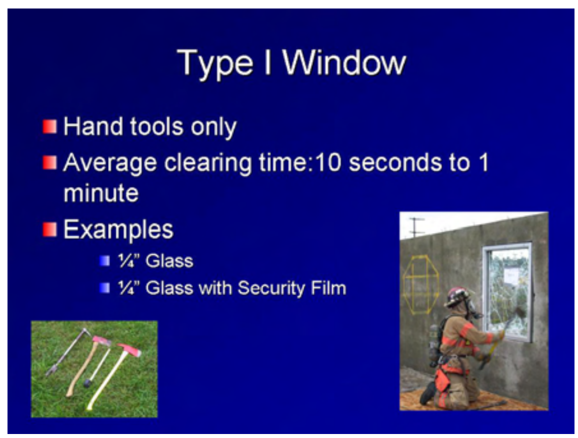
Let's review Types and Procedures.

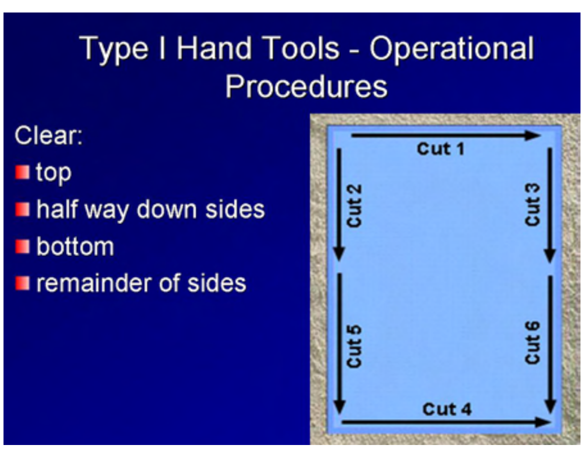




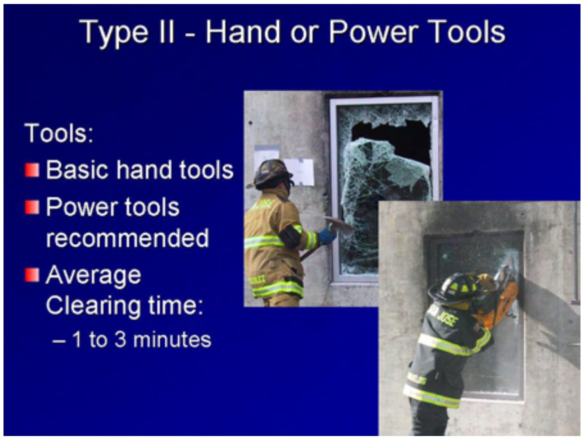
Type I windows call for only hand tools. Type II windows call for either hand tools or power tools. Type IIA windows are Type I windows on the exterior side of a building with a secondary system on the interior. Type III windows require the use of power tools.

Type I windows present minimal resistance to firefighter forcible entry. Basic hand tools are adequate and power tools are not required. The typical times to clear the entire window opening varied from 10 seconds to 1 minute.





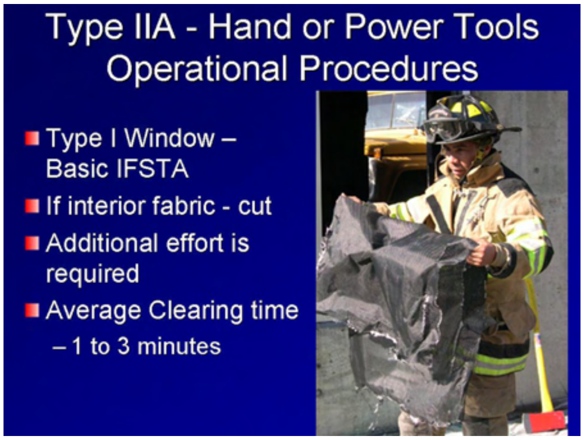
The best technique is to clear the top, clear halfway down the two sides, then the bottom, followed by the remainder of the sides.

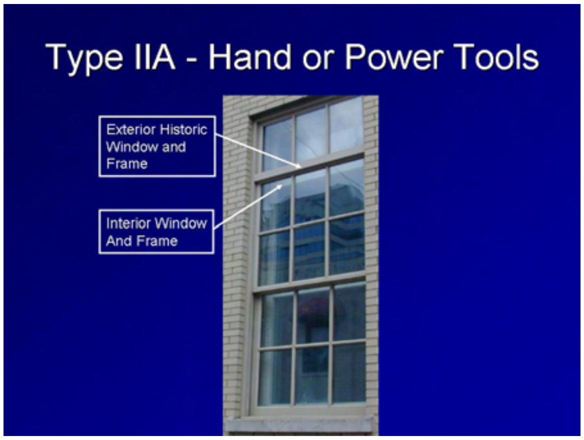


Type II windows call for either hand tools or power tools. Type II windows present much greater resistance to firefighter forcible entry than Type I windows. Clear times typically ranged from 1 to 3 minutes.

Standard firefighting hand tools are still adequate for forcible entry, but power tools may be the best method.

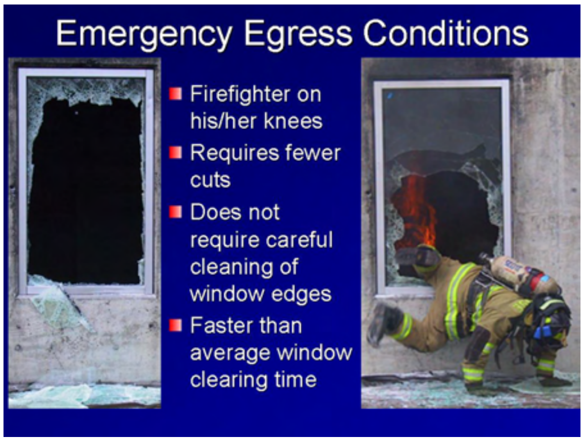
Type IIA windows are Type I windows on the exterior side of a building with a secondary system on the interior. The average clear time on these windows is 1 to 3 minutes, but it depends on the tools that you choose.





This window type often occurs at historic buildings which have been retrofitted for security purposes.

Type III windows require the use of power tools for forcible entry. Clearing and vent times will be dependent on the window and tools used, but are typically up to 5 minutes or more. When encountering a Type III window, firefighters should wear their SCBA to protect against the glass dust.



One major concern is the scenario of a firefighter mayday. Except for the Type III windows (which cannot be broken using hand tools) it was found that the emergency escape situations took less time than the forcible entry.