Subject 2326

1655 Scott Blvd.
Santa Clara, CA 95050
December 17, 1999

TO: Fire Council of Underwriters Laboratories Inc.,
Casualty Council of Underwriters Laboratories Inc.,
Others Interested

SUBJECT: Releasing Systems for Window Bars in Residential Occupancies

SUMMARY OF TOPICS

This bulletin documents UL observations regarding window bar releasing systems used in residential dwelling units. It includes information on the following topics.

1. An analysis of the use of fixed and releasable window bars in residential dwelling units, along with related building code requirements, enforcement and jurisdictional considerations, and socioeconomic issues.

2. A summary of findings based on the examination of several window bar releasing systems installed in the U.S., including construction and performance characteristics and identification of potential failure modes.

3. Preliminary construction and performance requirements for window bar releasing systems.

This information is being distributed in the interest of public safety and is intended to serve as a basis for developing regulations for window bar releasing systems that can be adopted by local and state jurisdictions that are seeking to regulate these systems.

To date UL has not certified any window bar releasing systems. If any such systems are submitted for investigation, the findings included in this report, along with other appropriate requirements, will form the basis for such an investigation. If sufficient interest is expressed in this area, UL may consider using this information as a basis for developing a Standard for Safety.

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COMMENTS

Written comments on this topic should be sent to the attention of Howard Hopper at Underwriters Laboratories Inc, 1655 Scott Blvd., Santa Clara, CA 95050. Comments may be sent by mail or faxed to 408-556-6045. Please reference all correspondence to Subject 2326.

Unless specifically requested to do so, UL will not acknowledge comments indicating concurrence with these proposals.

UNDERWRITERS LABORATORIES INC.

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Contents

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I. FOREWORD

Background - Underwriters Laboratories Inc (UL) has been requested to determine whether it is possible to develop a standard to evaluate releasing systems for window bars used in residential occupancies. This interest was prompted by recent multiple fatality fires in residential dwelling units where the occupants were unable to escape through fixed window bars.

Research Project – As a result of this interest, a research project was undertaken by UL to determine whether applicable requirements could be developed for investigating window bar releasing systems. This project involved a review of building and life safety code requirements, examination and testing of products currently on the market, and an analysis of factors associated with both fixed and releasable window bar systems. UL determined that the following criteria had to be met before a Safety Standard would be developed.

1. The Standard must provide an acceptability level of safety. A standard must include requirements that ensure that window bar releasing systems will operate consistently and reliably over the expected life of the installation. This reliability and operability must consider the level of periodic maintenance and testing that will be provided for these systems.

2. The Standard must include appropriate, reproducible test requirements. Tests developed to evaluate the performance of window bar releasing systems must provide consistently reproducible results. The tests developed must also accurately represent conditions anticipated in actual use.

3. The Standard must provide for cost effective construction. In order for homeowners and tenants to be realistically expected to install window bar releasing systems as an alternative to fixed non-releasable window bars, the releasing systems must provide an acceptable deterrent against a break-in, and do so in a cost effective fashion.

Findings - An examination of window bar releasing systems currently on the market, along with findings on installation, maintenance, testing and use issues raised significant questions about the ability of these systems to operate consistently and reliability during their anticipated lifetime. Since the investigation did not demonstrate that all of the three conditions described above could be met, a Standard for Safety for window bar releasing systems was not published with this report.

Draft Requirements – There are thousands of fixed window bars installed on dwellings in the U.S. that contribute to an increasing number of fire fatalities. At least three states have passed legislation that requires state agencies to develop regulations for window bar releasing systems[1]. Several state agencies and local authorities having jurisdiction have contacted UL for assistance in their efforts to develop such regulations. In the interest of providing a foundation for these regulations, a draft set of construction and performance requirements for window bar releasing systems is included as Appendix B. It is anticipated that the agencies and jurisdictions will review the information included in this report, examine the concerns expressed with the systems, and develop a comprehensive set of regulations based on this initial work and their own findings. If, at a later date, the concerns noted in this report are addressed, UL reserves the right to use these draft requirements to develop a UL Standard for Safety.

Meetings – Safety issues associated with window bar releasing systems were discussed at a number of meetings with various organizations, including those noted below. Many of the findings in this report were based on information and opinions received from building officials and fire service personnel.

[1] Related legislation includes California 1997-98 A.B. 1987, 1997 A.B. 1616 and 1998 S.B. 1405; Texas 1999 S.B. 839, Massachusetts 1999 S.D. 646, 1999 S.B. 545.

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September 3, 1997 - ICBO Peninsula Chapter Meeting, Santa Clara, CA
October 30, 1997 - ICBO Peninsula Chapter Security Bar Task Group Meetings, Milpitas, CA
November 17, 1997 – Combined meeting ICBO Peninsula Chapter Security Bar Task Group and National Security Bar Committee
January 6, 1998 - Window Bar Ad Hoc Meeting, Northbrook, IL
March 11, 1998 - California Building Officials Annual Meeting, Orange County, CA
April 27, 1998 – State Farm Research Center, Bloomington, IL
April 28, 1998 – Underwriters Laboratories Window Bar Ad Hoc Meeting, Northbrook, IL
May 5, 1998 - UL Fire Council presentation, Oakbrook, IL
May 17, 1998 – Security Bars Forum, NFPA Annual Meeting, Cincinnati, OH
September 2, 1999 - ICBO Peninsula Chapter Meeting, Santa Clara, CA
September 22-23, 1998 – State Farm Research Center, Bloomington, IL
April 22, 1999 – Window Bar Ad Hoc meeting, San Ramon Fire Protection District, San Ramon, CA
May 17, 1999 – NFPA Home Security & Fire Safety Task Group Meeting, Baltimore, MD

Many organizations provided valuable input into this effort. In particular, we would like to extend special thanks to the following organizations for their assistance.

National Fire Protection Association
State Farm Fire and Casualty Insurance Company
The Peninsula Chapter of the International Conference of Building Officials
The McMullen Company

II. SITUATION ANALYSIS

1. Products Covered

Window Bar Usage – Window bars, commonly referred to as burglar bars, are frequently installed over windows of homes in high crime areas in order to increase the physical security of the home against break-in. In most cases metal bars with no releasing mechanisms are bolted directly to the building over the ground floor, basement and sometimes upper story windows. Barred gates with double deadbolts or other locking means are also installed over the entry doors. These bars are intended to provide visible physical protection against break-ins. Their presence on a home may provide deterrence against break-ins. Residents of high crime neighborhoods frequently view this protection as an important safety factor. Becoming trapped in the home by fixed bars during a fire may seem a remote possibility, if the residents consider it at all. This is because residential fires occur much less frequently than crime in many neighborhoods where window bars are installed.

For the purposes of this project, window bars are defined as follows:

Window bars. The term 'window bars' refers to metal and other bars, grills, grates, heavy duty screens, glazing and other barriers that are designed to cover escape windows in residential dwelling units and deter a forced entry into the dwelling.

Products Not Covered – This report does not cover the following type of window bars:

Window bars used to prevent children from falling from open windows in upper floors of buildings. These systems serve a much different purpose than those covered by this report. Requirements for fall prevention systems are included in the recently developed ASTM PS112-98 Provisional Standard Safety

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Specification for Window Fall Prevention Devices for Non-Emergency Escape (Egress) and Rescue (Ingress) Windows.

Window bars protecting nonresidential and commercial properties are not covered by this report since windows in these buildings are not relied upon by building codes to serve as a secondary means of escape. Most of these commercial occupancies are required by code to have an exiting system that does not rely on a window escape path.

2. Fire Fatalities

Fire Fatalities - Several fatal fires have claimed lives in the past several years in homes with bars installed across the windows and/or exterior doors. In many cases occupants trapped inside were unable to escape through the barred openings and perished in the fires. Some of these victims died at the blocked openings while attempting to escape the fire. The frequency of these tragic fires has increased significantly compared to a decade ago.

REPORTED FATALITIES ASSOCIATED WITH WINDOW BARS

November 1999, Boynton Beach, FL: Father of three died in house fire, body was discovered on the living room floor, bedroom windows barricaded by heavy metal bars may have prevented his escape.

March 1999, Glascow, Scotland: Two men, both 20, died in their blazing flat. Investigators believe they tried to smash basement windows behind iron bars in a desperate attempt to escape the flames.

January 1999, Trenton, NJ: Metal anti-crime window bars hampered rescue efforts in an apartment fire that killed one boy and critically injured a pair of six-year-old twins.

September 1998, San Antonio, TX: Two young brothers, 3 years old and 23 months died in a house fire when firefighters and neighbors were unable to reach them through metal window bars. Neighbors did rip open the back door with a sledgehammer to rescue the boys' 5 month old sister and teen-age aunt.

March 1998, Easton, CA: An elderly couple died in their home during a fire, window bars bolted to the walls prevent their escape through the windows. Security bars on the doors prevented people outside from reaching the man, who was apparently trying to reach the door latch from the inside.

April 1997, East Palo Alto, CA: Nine people die trapped in their burning home by window bars.

April 1997, Philadelphia, PA: A mother of two, 46, dies in an apartment fire. Firefighters' had a difficult time getting in because of security bars.

February 1997, Ybor City, Fla: Four children, ages 6 through 12, were killed in an early morning house fire. Burglar bars hampered firefighters' attempts to rescue them.

September 1996, Long Beach, CA: A man, 62, dies. His wife, 50, in critical condition. Son, 20, escapes through a door in his bedroom, Dead smoke alarm batteries and security bars. Neighbors tried to use a hammer to break through the bars.

February 1996, Memphis, Tenn: Two children, ages 4 and 6, were killed and a woman critically injured. Burglar bars on windows.

October 1995, Oakland, CA: Five children die after their mother escapes fire but cannot get back inside, blocked by locked door and steel bars on windows.

July 1995, Miami: A woman, 47, and her daughter, 11, trapped inside their house. "The little girl was at her window yelling: "Help me! Help me!" said a neighbor, "She was trying to break the bars and everything, but she couldn't" Firefighters tried using a crowbar on the security bars but failed.

February 1995, Milpitas, CA: A woman, 35; man, 39, and their two sons, 10 and 3, perish in their home, unable to get past locked security gate and unmovable window bars.

January 1995, Los Angeles: A woman saves her two sisters by forcing open an emergency foot lever that released the security bars on a back bedroom window. A woman, her son, 2, daughter 3 and son 11 months, died, The bars in their bedroom did not have a release mechanism.

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January 1995, Los Angeles: A twelve-year-old dies in converted garage where he lived with three brothers, sister and mother. No smoke alarms or safety latches on barred windows. His twin suffers first-degree bums and was in guarded condition. Two other brothers escape without injury. A sheriff's deputy pries off iron bars on a back window, but was burned when he tried to go into the house.

January 1995, St Petersburg, Fla.: Two die. Door locked with deadbolt opened only with key from inside; bars on windows.

November 1994, Sacramento: Dead battery in smoke alarm and iron window bars hamper rescue of 63-year old woman. A Sacramento Fire Dept. representative says. “Had those bars not been there, we might have been able to save her."

July 1994, Memphis, Tenn.: A boy, 4, dies of smoke inhalation. Two adults and five other children survive. Smoke detectors worked, but burglar bars prevented neighbors from saving Terence.

June 1994, Phoenix, Ariz.: Unidentified man dies in home where he had been working. Residents say they saw the man, yelling and banging, trying to break out the windows but couldn't because they were covered with permanent security bars and chain link fence.

May 1994, St. Louis: A woman (no age given), dies from burns, her two young sons in critical condition with burns. Neighbors tried to help but bars on windows were too hot to touch. Firefighters cut through with gas-powered torches. Two family members escape through a door. Keys were in locks of the bars, but the victim couldn't get to them. "All we heard was screaming and breaking glass, and by the time we figured what to do, we didn't hear any screaming," said a man, who lives nearby.

February 1994, Mound Bayou, MIss: A woman, 68, her son, 34, and her brother, 74, die in their home. "I believe if they hadn't had those bars on the windows, we would have been able to save all of them," said a representative of the Mound Bayou Fire Dept

January 1994, North Las Vegas, Nev: A girl, 8, and two boys, 8 and 7, die in their grandmother's home. She had placed herself between the fire and some of the children as a human shield, firefighters said. The woman, 58, and a boy, 6, were critically injured. A police officer sustained bums and injuries to his shoulder struggling to break through security bars and a steel-barred side door. The woman is the mother of two Las Vegas firefighters.

January 1994, Louisville. Kan: A woman, 74, dies in a fire at her home after firefighters have to cut through heavy security bars in an attempt to rescue her.

December 1993, Greenville, MIss: A woman, 39, found dead in her home after a fire. Rescue attempts were hampered because of deadbolts on the doors and burglar bars on the windows.

February 1993, Detroit: Seven brothers and sisters, ages 9 years to 7 months, die. Left home alone, the children were barred from escape by windows blocked by an unhinged door. All the other windows in the home had bars.

January 1993, Bruce, Miss.: A woman, six grandchildren and one great-grandchild die in their home. The landlord had put steel bars on the windows to keep neighborhood junkies out.

November 1992, Detroit: A woman and her 3 year-old son die in home with bars blocking exits.

December 1991, Tampa, Fla.: A man, 57, dies on way to hospital after neighbors and then firefighters struggle through cast-iron security bars.

November 1991, St. Louis: Five-year-old killed, four brothers and sisters, ages 4 through 20 years old, in critical condition. A man found huddled with two injured children in a bedroom with a barred window.

August 1990, Los Angeles: A man, 56, and woman, 51, die in fire. Flames blocked only doorway; unremovable bars covered apartment's single window.

January 1988, Los Angeles: Pregnant woman and three children die. Firefighters and neighbors heard scratching as they fought to get in to help past non-release security bars and bolted door.

December 1987, San Bernardino: Two children, ages 10 and 12, die in their home, after mother and another child escape. Security bars on windows and doors with no quick release mechanisms.

June 1986, Los Angeles: Two boys, about 3, and a girl, age 1, die. Firefighters arrive to find neighbors trying to pry bars off to get to victims.

January 1986, Dallas: Seven family members die trapped by burglar bars. One of three who survived said he broke windows with his bare fists trying to save his mother, three sisters, two nieces and a nephew. Those who got out escaped through the one unbarred door.

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February 1984, Montgomery, Ala.: Five die in boarding house fire where first-floor exits were blocked by bars.

Source: San Jose Mercury News – 1997, and subsequent news clippings.

3. Code Requirements

General - Model building codes and the NFPA 101 *Life Safety Code* prohibit window bars from being installed on windows in residential dwelling units which are likely to be used as a secondary means of escape in the event of a fire. These are typically windows in sleeping rooms, and basements with habitable space. These codes allow bars to be provided on these secondary escape windows if they can be quickly opened from the inside by building occupants without the use of tools, keys or special knowledge or effort.

Window bar releasing systems are required when window bars are used on windows required to serve as the secondary means of escape. Depending on the specific building codes being considered, these are typically windows within 20 feet of the ground, windows which open onto a balcony, or windows that are accessible to fire department rescue apparatus.

Applicable Installation Codes - These systems are intended for installation in accordance with the codes and code sections shown in the following table. References made in this report to code requirements are based on sections included in one or more of the following codes.

The *Life Safety Code, NFPA 101*, 1997 edition, published by the National Fire Protection Association, Sections 5-2.1.5, 21-2.
The *Uniform Building Code*, 1997 edition, published by the International Conference of Building Officials, Section 310.4.
The *National Building Code*, 1999 edition, published by the Building Officials and Code Administrators, International, Section 1010.4.
The *Standard Building Code*, 1997 edition, published by the Southern Building Code Congress International, Sections 1005.4, 1005.5.
The *International Residential Code*, scheduled to be published in 2000 by the International Code Council, Section 310.
The *National Building Code of Canada*, 1995 edition, published by the National Research Council of Canada, Sections 9.7.1.3, A-9.7.1.3

Fire prevention codes such as the NFPA 1 *Fire Prevention Code*, the *Uniform Fire Code*, the *National Fire Prevention Code*, the *Standard Fire Prevention Code,* the *International Fire Code* and the *National Fire Code of Canada* include requirements that require egress and escape systems to be maintained in an operable condition. This allows ongoing enforcement of residential window bar requirements by local fire department personnel after buildings are constructed and occupied.

Residential Dwelling Unit - For the purposes of this research project a residential dwelling unit is considered to be a single living unit, providing complete, independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking, and sanitation. It includes one and two family dwellings, and the apartments themselves within apartment houses where the occupants should be familiar with their surroundings. It does not include hotels, motels, dormitories, board and care facilities or other facilities where the occupants are transitory or nonambulatory.

Escape Versus Egress - The terms ‘egress’ and ‘escape’ both apply to similar concepts, the idea of providing a means for building occupants to evacuate the premises in the event of a fire or other life threatening condition. This is a fundamental concept in fire safe building design and is reflected in building and fire prevention codes requirements.

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Means of Egress. Most occupancies are required to have an egress system that includes two or more continuous and unobstructed paths of travel from any point in the building to a safe location outside the building, typically to a public way or street. Multiple exits that are remote and separate from each other allow building occupants to exit the building safely, even if fire or products of combustion block one of the exit routes. Exiting through a window is not an acceptable path for a required egress route.

Means of Escape. Building and life safety codes require residential dwelling units to be provided with an escape system, rather than an egress system. The concepts are similar, yet different. In these occupancies every sleeping room and living area must have at least one primary means of escape and one secondary means of escape, with some exceptions. The primary means of escape provides unobstructed travel to the outside of the dwelling unit at street or ground level, similar to a means of egress. The requirement for a primary means of escape is typically met by the door through which one enters and leaves the residential dwelling unit. However, the secondary means of escape may through a door independent of the primary means of escape, or via an outside window operable from the inside. The concept of means of escape is prevalent in single family home and apartment building construction.

Windows - Building and life safety codes do not require all windows in dwellings to be capable of being used for emergency escape. For example, living room picture windows are not required to be available for use as an emergency escape if primary and secondary escape means of escape are provided by doors or other passages leading from the room. These windows can therefore include fixed window bars without creating a code violation. Only exterior windows that are defined by the building or life safety codes to be in the secondary means of escape path from the dwelling unit are required to have approved releasing mechanisms on them, if they are provided with window bars.

Building and life safety codes typically require secondary escape windows to have a maximum sill height of 44 in. above the floor. In the open position the window must provide a clear opening of not less than 5.7 sq. ft, with a minimum width of 20 in., and a minimum height of 24 in.

The height of the windowsill and the window dimensions are important factors, since an occupant must be able to climb out of the window. The window must also be of sufficient size to allow rescuers to climb in through it.

Types of Protected Openings – Releasable bar systems in residential dwelling units can protect two distinct types of openings, those in the secondary means of escape route, and those in the primary means of escape route. For the purpose of this report, the following assumptions have been made.

Releasing systems that protect doors leading from the living area, including sliding glass doors, are considered to be in the primary means of escape route, even if in an actual dwelling the protected door is not a required primary means of escape. These systems are actuated each time occupants enter or exit the dwelling through the door, which could be thousands of times over the expected life of the system. An evaluation of the long-term operation of the system's actuating and latching mechanisms is necessary to ensure reliability and operability. In addition, building and life safety codes may include requirements for the latching and locking arrangements for these systems. Due to the scope of the research project, releasing systems protecting door openings are not covered by this report.

Systems that protect windows are considered to be in the secondary means of escape route. As such, bars protecting these openings are only expected to be opened during installation, periodic testing and maintenance, including possibly window washing. These systems are not operated nearly as frequently as systems protecting doors.

Escape Doors - Depending on the individual dwelling unit layout, and the presence of fire protection features, doors leading from the living area to the outside may be in either the primary or secondary means of escape path. In order to avoid confusion in the field, security bar systems intended for use over

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door openings should always be assumed to be in the primary means of escape. Doors in the path of escape from more than one individual dwelling unit, such as exterior doors serving a common hallway in an apartment house, are regulated by building and life safety codes as being in the means of egress path from the building.

Building and life safety codes require latches or other fastening devices on an escape door in a dwelling to have an obvious method of operation under all lighting conditions. The device should not require the use of a key, tool or special knowledge or effort to operate, and should be located within 48 in. of the finished floor. NFPA 101 requires the locking devices to not include more than one releasing operation to open. However, it allows existing security devices on dwelling unit escape doors to be located a maximum 60 in. above the finished floor level if not automatic latching, and to have two additional releasing motions.

Gates - Gates and security fences consisting of wrought iron railings or similar obstructions are sometimes installed around entry points into the home to extend the secured area outside of the exterior walls. Since these obstructions are in the primary escape travel path, security devices on them should comply with the same requirements as security devices protecting doors. If the design of the building is such that the gates are in the escape path of more than one dwelling unit, then they are considered to be in the means of egress path.

ADA and FFHA - The Americans with Disabilities Act (ADA) was signed into law on July 26, 1990. It contains guidelines for new construction, alterations or renovations to buildings and facilities, and for improving access to existing facilities of private companies providing goods or services to the public. Since ADA guidelines are not applicable in single family dwellings and individual multi-housing dwelling units, there do not appear to be applicable ADA guidelines that need to be considered when developing requirements for window bar releasing systems. However, the Federal Fair Housing Act (FFHA) includes accessibility requirements that may need to be considered for certain multi-housing units covered by the Act.

4. Enforcement and Regulatory Issues

Enforcement - The enforcement of regulations prohibiting fixed window bars in residential dwellings is an almost impossible task. Window bars are frequently installed after the building is occupied, and without a permit from the local building official. Most jurisdictions do not have enforcement programs in place or sufficient staffing to conduct code compliance inspections of existing single family homes and individual dwelling units after they receive a Certificate of Occupancy. In addition to a lack of enforcement resources, gaining entry to dwelling units is problematic at best, since occupants are not always home during normal business hours.

In a typical jurisdiction the local building department is responsible for verifying that single family homes are constructed in accordance with building code requirements. Building departments and fire departments are typically responsible for enforcing local building and fire code regulations for the construction of apartment houses and other multifamily residential dwellings.

In single family dwellings, once the Certificate of Occupancy is signed off and the building is occupied, there is typically no additional code enforcement done on the building unless the owner applies for a building permit for remodeling, repairs or additions. In some cases an obvious code violation or unsafe condition may result in additional inspections and enforcement action, but this is not a common occurrence. Fire department inspections are more frequently done on multi-housing dwelling units, such as apartment houses. However, these inspections are usually limited to the common areas and exterior of the building. The phrase “a man’s home is his castle” applies to the inside of individual living units, and these living units are rarely inspected after they are occupied.

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Community Involvement - In many communities local code officials are not able to effectively enforce

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regulations prohibiting illegal window bars. An exception seems to be in communities that have a heightened awareness of the hazards associated with the installation of illegal window bars.

Unfortunately it usually takes a fire and subsequent loss of life in a jurisdiction to make community leaders aware of the problem and to prompt local officials to address the problem. As an example, in the San Francisco bay area, three multiple fatality fires in a four year period prompted several local jurisdictions to actively identify existing dwellings with potential illegal window bars[2]. Upon learning the magnitude of the problem they began taking community wide action, including providing financial incentive packages to homeowners to remove illegal bars and replace them with approved releasable window bars systems[3].

If requirements are developed for window bar releasing systems that result in a significantly higher cost for the equipment and installation, it can not be expected it would be utilized in wide spread applications. This is especially true in low income housing areas where fixed window bars are most prevalent.

5. Socioeconomic Factors

Burglary Resistance - The primary reason that people install window bars is to act as a deterrent against forced entry into the home. Burglaries are often crimes of opportunities, in which the burglar is looking for an easy target. The mere presence of window bars often makes the burglar look for a different home.

Occupant Situation – Studies conducted by the National Fire Protection Association indicate that individuals in lower socioeconomic environments, with lower disposable income, are at an increased fire risk due to a number of factors. High crime areas are usually in low socioeconomic neighborhoods.

Many individuals in high crime areas are exposed to crime on a daily basis. Because of this exposure, the addition of window bars to their homes adds an immediate perceived improvement to their level of personal safety. Since residential fires occur on a less frequent basis than crime in these areas, individuals considering adding window bars to their homes, or those with fixed window bars already installed on their homes, may not be as attuned to the potential fire hazards presented by illegal bars. If they are aware of the hazards, they may feel that the added level of physical security provided by the bars far outweighs the potential problems created by the bars if fire occurs in their home.

Cost Considerations - Some fairly inexpensive methods have been used by homeowners to provide fixed window bars on dwelling units. These can be nothing more than wrought iron or steel tubing welded together and bolted on the side of a home. In some cases simulated wrought iron fencing has been purchased at home centers and bolted over escape windows. In order to be an acceptable alternative to low cost fixed window bars, window bar systems with releasing mechanisms must be competitively priced.

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[2] As an example, the Oakland, CA Fire Department identified over 10,000 residences with window bars on one or more windows.

[3] San Jose, CA established a block grant program with $1,000,000 funding to qualifying low income residences to remove their existing fixed window bars and install approved releasable window bars. Daly City, CA offers grants through a home re-hab program of up to $1500 per home to remove illegal bars and double-deadbolt locks.

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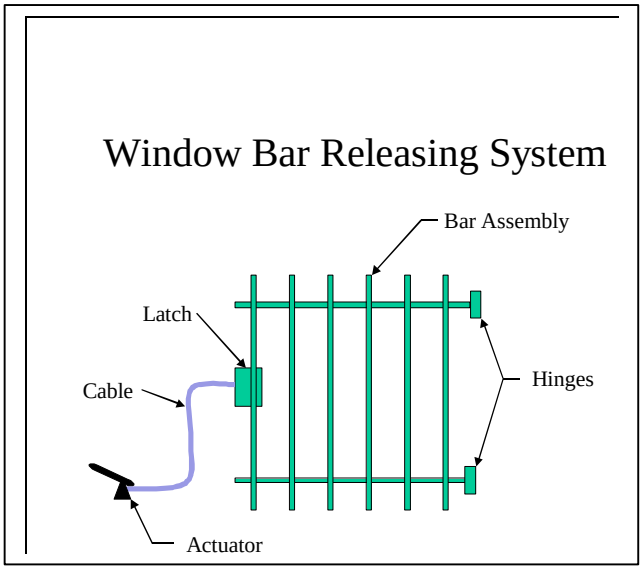
III. SYSTEM COMPONENTS AND OPERATION

1. System Components

General - Window bar releasing systems often include the components shown in the following diagram. Deviations between different models and manufacturers exist, but most systems components fall into the following categories.



Actuators are the mechanisms that are manipulated by occupants of the room in which the protected window is located. Operation of the actuator, which is usually located a few feet from the window on the interior wall, releases the latches which hold the bar assembly in place.

One or two latches are provided with each window bar releasing system. Latches engage a catch on the moveable window bar assembly and secure it in a closed position. Latches may be provided with springs that assist in disengaging the catch from the latch.

A cable or other remote connection means provides the mechanical link between the actuator and latch. However, some systems include an actuator that connects directly to the latch via a solid metal rod or connector.

Bar assemblies provide the physical deterrent against break-in. They may include cast iron bars, metal tubing, metal grills, or other barriers. They are usually provided with hinges on one side, and a latch on the other. They swing inward or outwards when the latch is released to allow for occupant escape.

Hinges provide the connection between the moveable bar assembly and the mounting brackets on the building wall near the edge of the window.

Window bar releasing systems are available that do not include all of these components. As an example, one system includes a means to mechanically disengage and remove individual bars in the bar assembly when the system is activated.

System Operation

A window bar releasing system should perform acceptably during normal closed conditions, and during emergency escape conditions.

Normal Closed Operation – Most of the time the window bar assembly will be in the closed (latched) position. In order to meet the expectations of the occupant, the system must appear to be sturdy enough to resist a forced break-in. However, it is probably not expected to resist an extended attack with power tools, powerful prying tools or repeated sledgehammer blows. It also must not be able to be easily opened from the exterior by a potential burglar reaching in through the window to actuate the release.

Emergency Escape Operation - Under emergency escape conditions the occupant will move to the window protected by the releasable bar system, locate the actuator and mechanically depress it. This motion will be mechanically transmitted through the cable or other means to the latch, which will disengage the catch on the moveable bar assembly. The bar assembly is then grasped by the occupant and moved out of the way so he or she can escape through the window.

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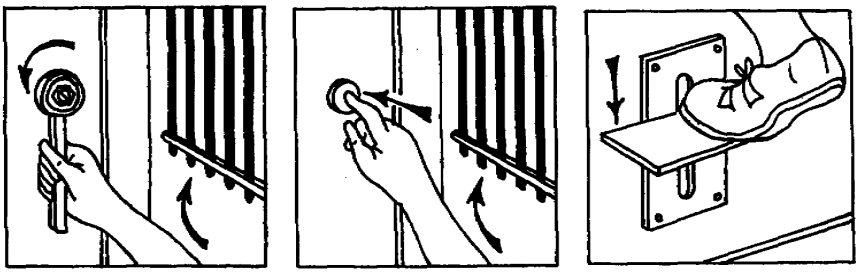
2. Actuators

The scope of this research is limited to systems that are physically manipulated by the occupant. Some interest has been shown in systems that automatically release the bar assemblies by activation of an automatic smoke or heat detection device. However, automatically actuated systems were not available for examination, so they are not addressed in detail in this report.



Releasing systems examined include finger, hand and foot operated actuators. Actuators can conceivably include the following means of actuation:

Finger actuated: Pushing with the index finger, or pulling a loop with the index finger in a curled position.

Hand actuated: Pulling, pushing, twisting, rotating or turning a lever, knob, handle, rod or similar actuator with the hand or multiple fingers.

Foot actuated: Kicking, depressing or stepping on an actuating pedal, lever, stirrup or similar actuator.

Actuation Criteria – In order to be effective the actuator must allow occupants to release the bars quickly and with simple, easily understood and intuitive motions. The actuators must be easy to operate in all lighting conditions. They should not require two different forces to be applied at the same time, such as applying force to the actuator while also pushing on the bars. The forces required to operate the system and open the bars should not be difficult to apply. Under ideal conditions the occupants should be familiar with the operation of the releasing system, and have periodically operated it. Realistically this may not always be the case, but at the very least the occupants should be aware of where the actuator is located. Actuators should not require the use of a key, a tool, or special knowledge or effort for operation from the inside of the building.

Release Location - The location of the actuator is an important consideration. To be practical, actuators must be mounted in locations where they can be easily operated by the body part anticipated. For example, foot operated actuators should be located near the floor, where a typical occupant can actuate them. Hand and finger operated actuators can be mounted higher on the wall, and still allow the occupant to provide the force and motion required to unlatch the bar assembly. However, the higher the actuator is located above the floor, the sooner it will be obscured from view in the upper smoke layer of a fire.

Factors to be considered with regard to the actuator location should also include potential damage that may occur if the mechanism is struck by furniture or vacuum cleaners, or played with by toddlers and children. Also, the location chosen may result in the actuator being blocked or hidden by furniture or draperies.

Based on NFPA 101 requirements for existing non-automatic latching security devices on residential dwelling unit doors, it does not seem unreasonable to allow actuators to be mounted on the wall a

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maximum of 60 in. above the finished floor. This will accommodate existing technologies that utilize an actuator that is connected to the latch via a metal rod routed through the wall. Among other factors this should allow it to be reachable to most building occupants who are capable of escaping from a window with a 44 in. high sill. Additional limitations on the location of the actuator may need to be considered if the dwelling is required to comply with accessibility guidelines under the Federal Fair Housing Act.

Actuating Motions – There is no definitive criteria in building codes for acceptable motions and forces required to disengage and open releasable window bars. Based on NFPA 101 criteria for existing locks and latches on escape doors in residential dwelling units, it does not seems unreasonable to allow window bar releasing actuators to require two distinct motions to disengage the latch. A double action motion seems reasonable, since building occupants who live in the dwelling should be familiar with the bars and actuators, as compared to individuals in a transitory dwelling, such as a hotel room. Once the bar assembly is disengaged from the latch, an additional motion is needed to move it away from the window opening.

Opening Forces – The investigation included a limited evaluation of the forces required to operate release mechanisms. A review of building codes did not provide specific requirements for maximum forces required to operate window bar releasing systems. ANSI A117.1 specifies a maximum 5 lb. force for the activation of operable parts. Although not applicable to window bar release mechanisms, NFPA 101 includes requirement for the maximum forces required to open exterior egress doors. These forces, noted below, were included in the Appendix B requirements for setting the bar assembly in motion and opening it to the minimum required width.

- 15 lb. to release the latch,
- 30 lb. to set the door in motion, and
- 15 lb. to open the door to the minimum required width.

A detailed ergonomic or anthropometric study of the ability of various occupants to operate a releasing system were not conducted during this investigation. However, as part of the sample examination at the State Farm Casualty and Fire Insurance Company research facility, six UL and State Farm personnel, all adult males, were polled to determine the force levels that they felt were reasonable to actuate a release system using finger, hand and foot motions. This informal and very limited survey was performed using a force gauge and simulated actuators. Each participant in the study was asked to apply the force they felt might reasonably be applied to each type of actuator. Foot applied forces did not consider limitations associated with applying the opening forces barefoot. Each individual applied the force ten times for each form of actuator. The subjects were not able to see the force gauge readout while applying the force. The results obtained were averaged, and rounded down to the values shown.

Preliminary Proposed Opening Forces for Unlatching Window Bar Releasing Systems

- Finger actuated systems should not exceed 5 lbs. average over five attempts, or 10 lbs. on an individual attempt.

- Hand actuated systems should not exceed 5 lbs. average over five attempts, or 10 lbs. on an individual attempt.

Foot actuated systems should not exceed 15 lbs. average over five attempts, or 30 lbs. on an individual attempt. Some foot actuated systems require a kick, rather than a steadily applied force to operate. The force to actuate these systems should be applied by swinging a 25 lb. weight on a four foot pendulum from ten inches away, measured horizontally.

This preliminary data developed by this very limited survey should not be considered to be complete, or

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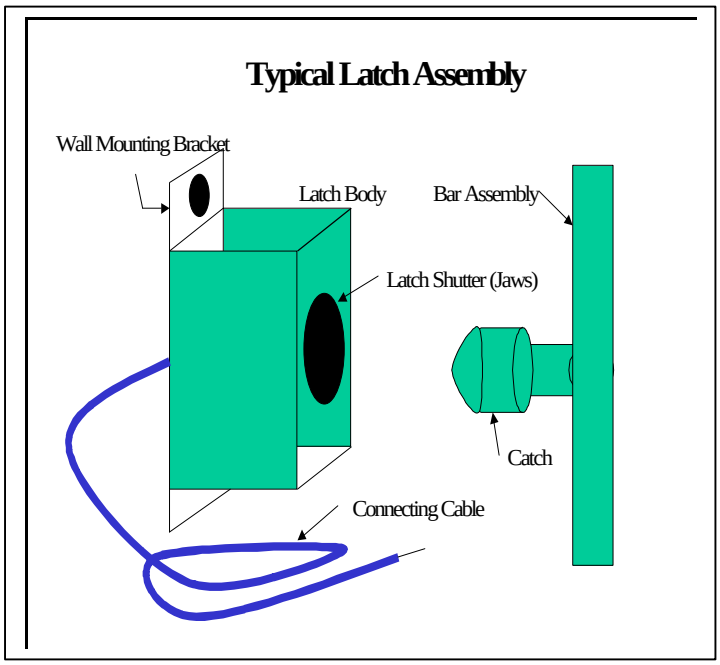
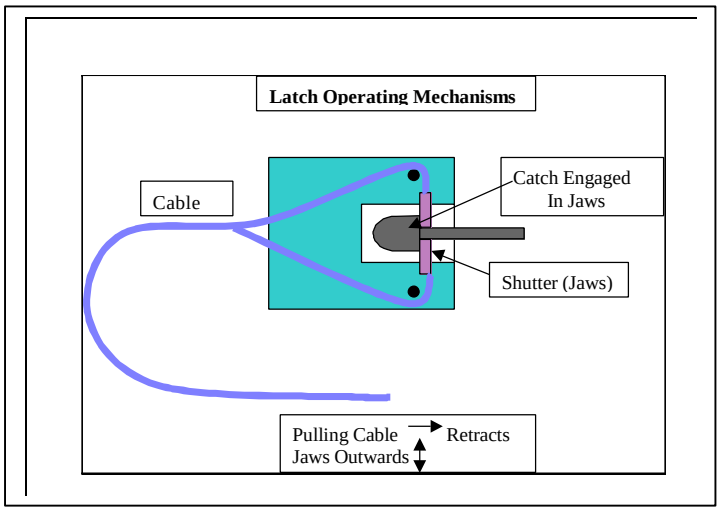
appropriate for all segments of the population who might be expected to operate the releasing mechanisms and escape through the windows. However, for the purposes of developing draft performance requirements and generating additional discussion on this area, the values shown above are being provided. UL reserves judgement on the acceptability of these force levels, and would welcome additional information in this area prior to continuing with the development of a Standard.

3. Latches

Latches are mechanisms used to secure the bar assembly in a closed position. They are mounted on the wall near the edge of the window, and are usually connected to the actuator with a steel rod or cable. A steel cable is often a factory installed integral part of the latch. A matching catch on the moveable bar assembly fits into the latch body and is secured by the jaws or shutter of the latch. The jaws open when tension is applied to the cable, thus allowing the catch to be disengaged.



Occupants expect the latch to securely hold the catch so the bars cannot be forced open. However, when the latch is actuated to disengage the catch and open the bars, it is expected to do so consistently and reliably. On some systems, proper alignment of the catch and latch are required for the system to disengage properly. Misalignment due to settling, improper installation or other factors can make it extremely difficult to disengage the catch from the latch. This is especially true if the shutter (jaws) in the latch body do not fully retract into the walls of the latch body.



The problem of misalignment is especially pronounced when the latch is fixed to the building wall, the catch is fixed to the bar assembly and there is no opportunity for the catch to float laterally in the latch channel.

4. Connection Means

Cables similar to those used on bicycles are used in many systems on the market today. The cables are typically connected to the latch shutter mechanism in the factory. Several feet of cable are provided so the actuator can be installed on the wall at a suitable distance from the window. In some cases a coiled metal sleeve, similar to a spring, can wrap around the cable where it penetrates walls or passes by sharp corners to provide additional physical protection against damage.

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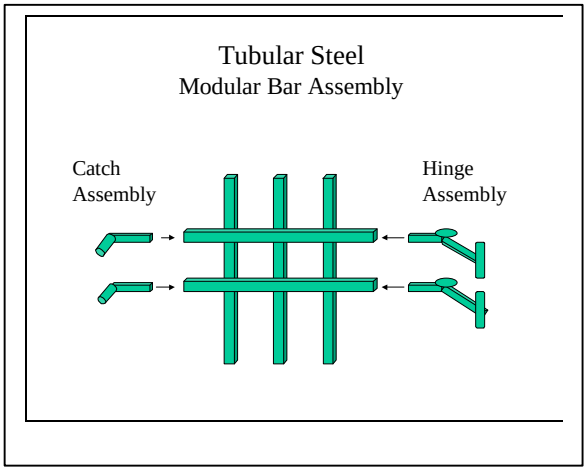
Certain window bar technologies do not utilize a cable for remotely locating the actuator away from the window. Instead a steel rod may be used to connect the steel rod on one side of the wall to the latch on the other.

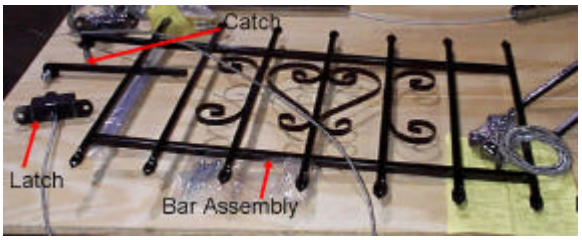
5. Bars and Grills

A variety of different bar assemblies are available. Companies who supply releasing system components fabricate some bars. Local ornamental metal fabricators, who often produce customized wrought iron products, also fabricate bars.

Several systems examined were constructed of tubular steel, with a hollow core. This construction appeared to be sturdy, and allowed the mounting components such as hinged mounting brackets, to slide into the bar crosses pieces, as shown below. Fixed mounting brackets can also be used to mount the bar assembly on windows that do not require releasing hardware.



Grills are also used in many parts of the country, in lieu of this type of bar assembly. In addition telescoping bar assemblies are used on some inside bar systems. These basically expand to fit the window to be protected. See Appendix A for details on these systems.



Modular Bar System

One concern with bar assemblies relates to potential head entrapment by a small child in the bar assembly. To address this issue, the Appendix B requirements do not allow a 4 in. diameter sphere from passing through any opening in the bar assembly, which is similar to a building code requirement for railing on stairs.

6. Hinges

Hinges are relied upon to operate consistently without binding. Smooth operation of the hinges is necessary for the window bar system to be disengaged and opened with no significant increase in opening (actuation) force. Corrosion, rust, ice build-up and dust contamination are factors that can adversely affect the operation of the hinges. Binding of misaligned bar assemblies may also be a concern. Hinges that are impaired will doubtlessly increase the forces required to disengage and open the window bar assembly.

Modular Bar Assembly Hinges

We were told that certain hinge designs are more resistant to corrosion than others. However, specific details on these hinge attributes were not provided. This investigation did not evaluate the impact that rusted or impaired hinges had on system operation. It is assumed that the relative increase in opening force attributed to impaired hinges may be less for a wider bar assembly than a narrower one. This is because the

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increased lever arm provided by a wider bar assembly provides a greater torsional force on the hinge for an equivalent lateral opening force applied at the latch. The adverse affects of hinge corrosion or binding may be minimized if the system is periodically operated, maintained and lubricated.

Concern was expressed about window bar releasing systems with hinges mounted at the top of the window opening, which require the bars to be pushed up to create an escape opening, although such constructions were not available for examination. This concern relates to the possibility that it may be difficult to open bars upward, or that the bars, when released, can fall and trap an individual in the window opening.

Due to the limited information provided on hinges and their resistance to corrosion, the draft requirements in Appendix B only include a simple statement that requires hinges to operate smoothly and not be unduly susceptible to rust or corrosion. Additional information on this area is needed to properly evaluate designs incorporating hinges.

7. Springs

Springs are used in some systems to provide mechanical assistance for disengaging the latch from the catch on the moveable bar assembly when the system is actuated. Springs are commonly compressed between the bar assembly, and are secured to the latch or catch. In many systems, depressing the actuator only momentarily opens the latch mechanism. The spring is often relied upon to move the catch on the bar assembly out of the jaws of the latch. When the actuator is released the occupant can then move the bar assembly to its full open position.

If the spring was not provided on systems which only momentarily release the latch mechanism, then the user would be required to concurrently depress the actuator and at the same time apply force to the bar assembly to clear the catch from the jaws of the latch. Our examination of systems concluded that performing these actions concurrently is not necessarily an intuitive action for people to take. This is especially true for foot or hand operated systems. In these systems, once the actuator is depressed or kicked, it is common for the user to attempt to force open the bars. When this is unsuccessful, it is natural for the occupant to try and depress or kick the actuator harder, rather than attempt the actuation and physical bar movement at the same time.

For these systems the springs must be highly reliable, and of sufficient strength to disengage the catch from the latch under normal conditions. It must also be of sufficient strength to disengage the catch under less than optimum conditions that might be experienced in the field. This includes, among other things, misalignment, corrosion and icing conditions during which the force required to disengage the catch may substantially increase, as compared to the normal optimum spring force required.

There are two ways to approach this issue. One approach is to require the spring to be highly reliable and maintain sufficient force to disengage the catch under conditions likely to occur during its expected lifetime. Alternately, the system could only use springs for supplementary purposes, and not be relied upon to disengage the catch.

The draft requirements in Appendix B specify that the release mechanism cannot depend on springs to release the latch, although springs may be provided to assist in the operation. They also require springs provided in the latch or on the bars that are intended to move the bars from the latched position to be removed or disabled prior to testing.

A comprehensive study on long-term spring reliability under a variety of conditions was not performed during this study. This type of research would be useful in developing alternative requirements for these springs.

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IV. FAILURE MODES

1. Potential Failure Modes

The sample examinations and testing conducted during this study identified a number of potential failure modes that, if they occurred during a fire condition, could prevent the occupants from escaping through windows protected by window bars. These findings are summarized in the failure analysis diagrams included in Figures 1, 1A and 1B.

The failure analysis diagrams do not consider the cumulative effects of multiple events, such as a weak spring, slight misalignment and light corrosion on the operability of the releasing system. In addition, a specific failure mode, such as misalignment, could be replicated in several portions of the logic diagram. In order to simplify the figures, failure modes common to more than one branch of the logic diagram are not necessarily repeated under each branch.

Fig 1 - Failure Analysis

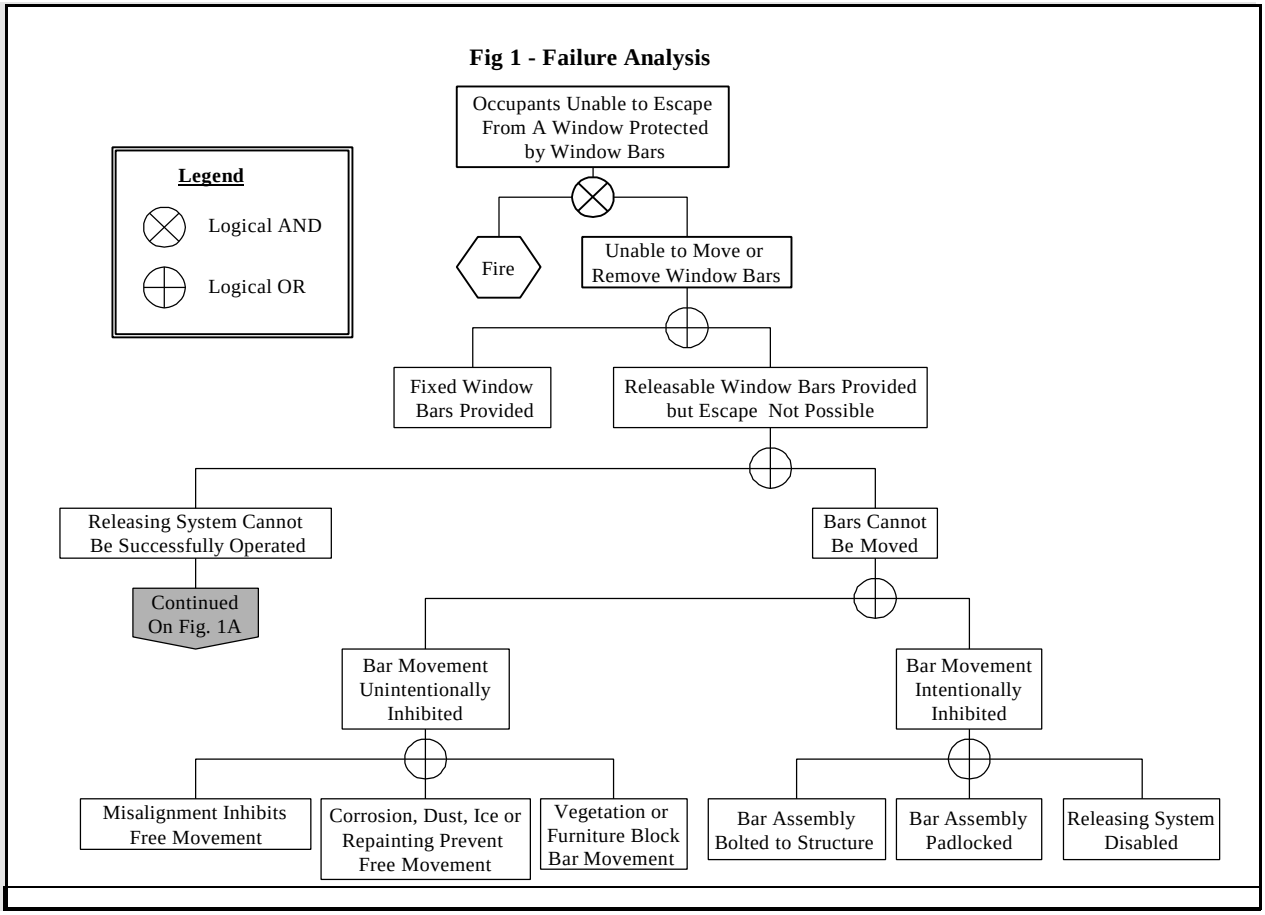

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Fig 1A - Failure Analysis (Continued)

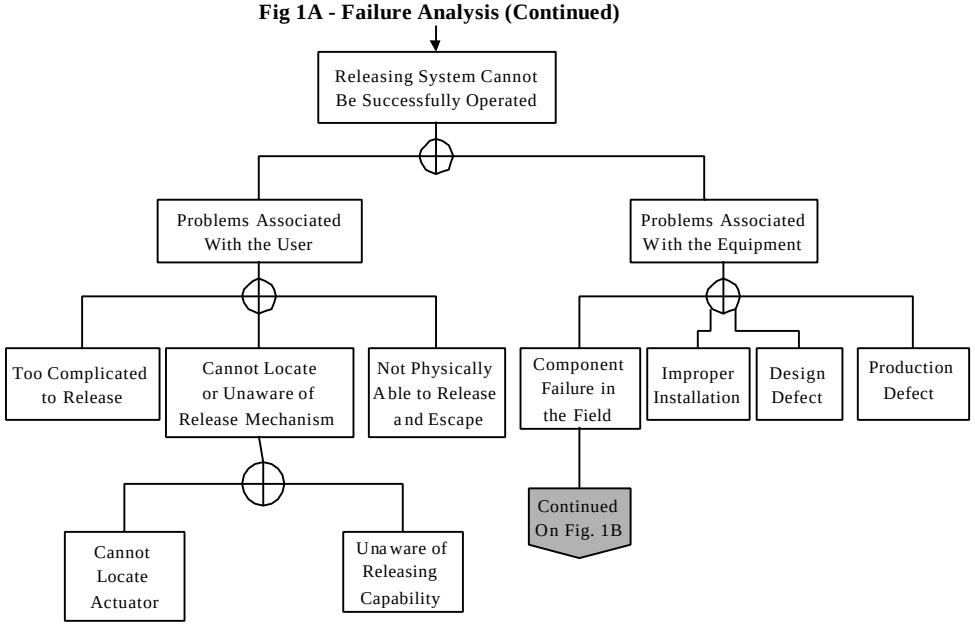

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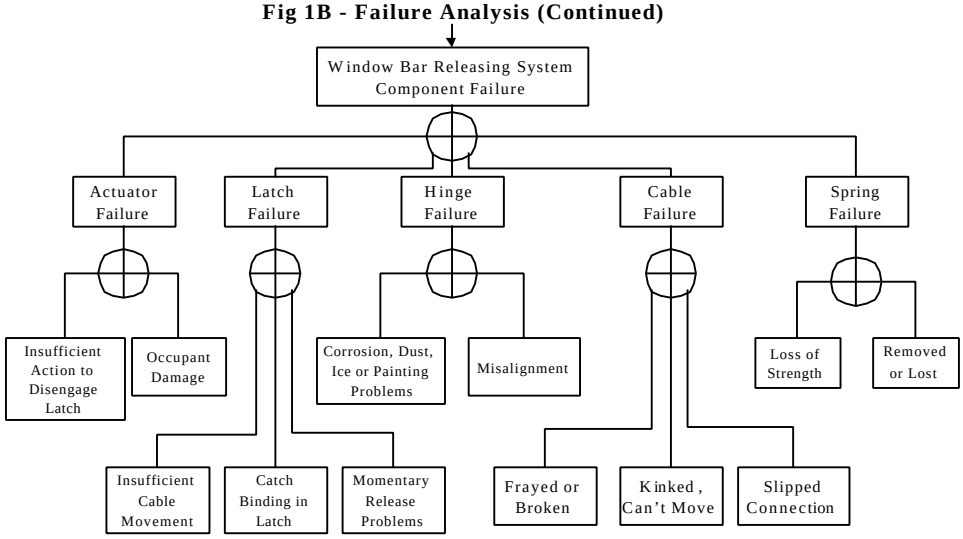
Fig 1B - Failure Analysis (Continued)



2. Obstructions

Failures of the releasing system due to obstructions are a site-specific issue that cannot be mitigated by an equipment standard. Obstructions can inhibit the operation of systems with either interior or exterior bars.

Obstruction of the bars can occur a number of ways. Vegetation growing near exterior bars can prevent them from being able to swing open, even if they unlatch successfully. Trees, bushes and vines all have the potential to inhibit the bar assembly movement. Interior bars which swing inwards may be blocked by heavy furniture, which may prevent them from swinging open.

Unfortunately we have examined systems that include a hasp for padlocking the bar assembly shut. As previously discussed, codes do not allow bars to require a key to open, so this arrangement is unacceptable. The draft requirements in Appendix B do not allow the system to include construction that allow it to be locked in a closed position with a pad lock, or a pad lock and steel chain or cable. Hasps, eyes or similar construction cannot be provided, and the construction must be such that the moveable portion of the system cannot be chained or locked to the non-moveable portion of the system.

Heavy furniture may also obstruct access to the actuator, which can prevent the occupant from getting to it in an emergency. This furniture can also damage the actuator or connecting cables, which can inhibit system operation.

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3. Misalignment

Many of the systems examined were very sensitive with regard to alignment of operating parts, in particular alignment of the catch into the latch. Misalignment of these components can dramatically increase the opening force required to disengage the window bars, or prevent the system from being released at all.

Misalignment can occur either during installation, when an installer, particularly a homeowner, may not properly align the bar mounting brackets in relation to the wall mounted latch assembly. Good installation instructions and a forgiving, user friendly design may alleviate some of these problems. However, structural settling due to normal house movement or seismic activity may cause a properly installed and aligned system to become misaligned.

The draft construction and performance requirements in Appendix B do not include specific requirements to evaluate the impact that misalignment has on system operation. This is an issue that can be addressed through a thorough initial acceptance test of the system, and on-going periodic system testing.

4. Environmental and Aging Considerations

Several components in the system are relied upon for the system to operate reliably throughout its expected lifetime. Any degradation of these components may lead to failure of the entire releasing system. The following conditions may contribute to potential system degradation:

- Corrosion – This is of particular concern for components that are exposed to the elements, and those systems used in coastal areas.
- Repainting – Homeowners can be expected to repaint the bars periodically, and cannot be relied upon to keep paint off of critical operating parts.
- Blowing Dust – Operating mechanisms may become clogged with dust and grime build-up in geographic locations that are subject to unusually heavy dust storms.
- Ice Build-Up – Exterior mounted window bar releasing systems in cold climates may be subject to ice build-up.
- UV – Ultraviolet radiation exposure from the sun can degrade polymeric components used in the system.

The draft requirements in Appendix B include corrosion resistance requirements for ferrous metal parts. These may sufficiently protect some parts for their expected lifetime, but may not provide an acceptable level of protection for critical operating components.

Periodic repainting of critical system components, especially the hinges and latch mechanism, may inhibit the operation of the system. During this investigation an effort was made to find published performance requirements that would simulate repeated repainting of the critical system components.

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We were unable to find any such test, and did not have the time needed to develop a test to evaluate the performance of systems after repainting.

The presence of excessively high levels of blowing dust can possibly affect the operation of the system, in particular the mechanical operation of the latch, cable and hinges. No tests were developed during the investigation to address this potential concern. Due to this concern, the draft requirements in Appendix B specifically do not apply to exterior systems in areas subject to blowing dust.

Systems mounted on the exterior of the building are subject to potential ice buildup in colder climates. Anecdotal information was provided that suggested that ice build-up in excess of two inches can reasonably be expected in some colder climates. We were unable to verify these claims, or simulate such conditions during the sample examination. Due to this concern, the draft requirements in Appendix B specifically do not apply to exterior systems in areas subject to ice and snow.

Ultraviolet exposure from the sun may affect the performance properties of polymeric materials used in the systems. In order to address these concerns, the draft requirements in Appendix B require polymeric materials to comply with the requirements of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, Sections 25-27, which cover permanence, ultraviolet light exposure, water exposure and immersion considerations.

5. Component Failures

Component breakdown can prevent the bar assembly from opening when needed. Some of the more common failures that were identified during sample examinations were as follows:

Cables – Cables used on many existing systems are similar to bicycle gear shifting cables. Unfortunately there are several significant failure modes associated with these cables and their intended usage. Exterior mounted latches use a cable that is routed through a hole drilled in the exterior wall. When the cable exits the wall it can become kinked when the installer attempts to make a 90-degree bend in it to run it across the interior wall to the remotely located actuator. Kinking the cable assembly can severely inhibit the free movement of the inner cable, making operation of the system either much more difficult or impossible.

Another significant problem with cables is the means used to secure the inner cable to the actuator lever. This is often done with a setscrew arrangement. If the screw is not tightened properly, or loosens over time, the cable will slip out of the actuator when it is depressed, and the system will be inoperative. Both of these conditions represent serious failure modes.

Frayed or severed cables also present a potential failure mode. However, this is somewhat mitigated by Appendix B draft requirements that require the cable to have at least ten times the tensile strength needed to operate the system.

Actuator – Actuators on cable operated systems are relied upon to pull the cable a distance sufficient to open the latch jaws to their full open position so the catch can be released. System failures can occur if this connection is not properly made and adjusted during system installation. Periodic adjustment may also be needed, especially if the cable stretches during use. Also since actuators are located on the wall in the room, they may be subjected to damage by being bumped by the occupant or furniture, or by being played with by children.

Latch – Three potential failure modes are of most concern with latches, momentary release concerns, binding of the catch in the latch body, and insufficient cable movement.

During sample examinations we noted that some latches included springs that are intended to force the catch from the latch. This is a critical action, especially when a momentary actuator, such as a kick type

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unit, is utilized, or even a hand operated lever type actuator. Our experience with these type systems showed that they worked well when the catch and latch were properly aligned, and the springs were operating properly. Under these conditions manipulating the actuator would momentarily open the latch, and the spring would disengage the catch. However, when the catch was misaligned in the latch, or if the spring was missing or weak, the catch would not clear the latch when it was momentarily opened. After operating the actuator the user attempts to swing the bar assembly open. When it does not move the natural tendency is to just strike the actuator with more force, and repeat the action multiple times. It is not an intuitive motion to push out on the bar assembly at the same time the actuator is being operated. This was a significant fault condition.

Binding of the catch in the latch is also a fault condition that was observed. In some cases the internal jaws or shutter did not retract enough to release the catch. In other cases a misaligned catch got hung up on a protrusion in the side of the latch body. This fault condition can result from design, manufacturing and installation deficiencies. In addition, the cable movement produced by the actuator may not be sufficient to open the latch to a wide-open position. For example, the actuator may only pull the cable ¾ in., when a 1 in. displacement is needed to fully open the latch shutter.

Springs - As noted above, failure of the spring provided with the latch may prevent the user from successfully operating momentary action type latches. Such failures may be due to weakened or broken springs, or springs which became detached from their mounting location.

6. Human Factors

A variety of potential failure modes can be introduced by human interaction with the releasing system. These include failure modes introduced (1) during installation, (2) by damaging the system, or (3) by the occupant not being able to operate the system.

Numerous potential failure modes can be created if the system is not properly installed. Misalignment of components, as previously discussed may make it difficult if not impossible to release the bar assembly. It is important for the installer to properly layout holes to be drilled in the home, since they may be reluctant to redrill a misplaced hole. A homeowner is likely to try and misalign the system to fit a drilled hole, rather than redrilling the hole. The installer may also not properly adjust the system so operation of the actuator does not fully open the latch.

Occupants can also create potential failure modes by unintentionally damaging the releasing system while living in the home. This can result from impacts by furniture, vacuum cleaners and other objects, or from contact by the occupant or children. Occupants may also intentionally disable the system or permanently secure the bars closed, if they feel burglars can compromise the system.

Failure modes can also be attributed to occupants if they do not know the releasing systems are available for use, if they do not know how to operate the releasing system, or if they are physically unable to operate the system and escape through the window.

7. Product Defects

Releasing system components can include defects, other than those discussed above that result from design or production defects. A design that does not properly address all conditions to which the system is subjected during its useful lifetime may result in a system failure. An example may be operating parts that are not robust enough in construction to withstand repeated system testing and usage by a physically strong occupant. Production problems may also be a source of potential failure modes. Cracks in metal components, burrs on moving parts, not meeting acceptable production tolerances, or changing to less robust materials may lead to system failures.

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8. Reducing Failures

As can be seen a number of factors can lead to system failure. Construction and performance requirements can be developed to reduce the risk of some failures. However, these cannot be expected to reduce many of the failure modes that arise during and after installation.

Unfortunately window bar releasing systems are passive in nature, meaning they are rarely operated after installation. Because they are not used on a daily basis in the home, loss of function of the system, for any reason, may not be quickly identified and repaired by the occupants. On the other hand, loss of function of a frequently used feature of the home, such as an entry door that stick or becomes lodged in the door frame, is more likely to be fixed since the loss of function affects the occupant's daily lives.

Under the best of conditions window bar releasing systems may be operated a few times a year when the windows are cleaned, and during family fire escape practices, such as the Exit Drills in the Home (EDITH) program promoted by the NFPA. However, it is likely that in many homes window bar releasing systems may not be operated for years at a time, because nothing is prompting the occupant to do so.

Periodic operation, maintenance and repair would reduce the risk of most of the failure modes identified above. Conscientious periodic operation of the releasing system by the occupants would identify obstructions, misalignment, and degraded or broken components. Any problems with the systems discovered during these operations can be remedied through maintenance (adjustments, lubrication, cleaning and removing obstructions) and repair. In addition, having the occupants actually operate the releasing system familiarizes them with the existence and operation of the releasing system, and addresses some of the human factor failure modes noted above.

Getting occupants to periodically operate and maintain their window bar releasing systems is an important safety objective. However, getting occupants to actually operate and maintain the systems will involve a significant public education campaign. Organizations such as the NFPA Center for High Risk Outreach, and local fire department public education personnel can play an important role in increasing occupant awareness of this important safety issue.

Enforcing any form of periodic testing and maintenance of these systems will be problematic at best for local jurisdictions and insurance companies, since it is difficult to conduct inspections of individual dwelling units. Reinspections of such systems can perhaps be performed when the residence changes owners, or when permits are pulled for home construction or repair.

V. SCOPING AND CERTIFICATION ISSUES

1. Attack Resistance

Occupants of homes protected by window bars rely on them to prevent break-ins. The main purpose of the bars is to serve as a deterrent against a 'target of opportunity' break-in. Bars which appear to be of substantial construction, and cannot be easily defeated or released from the outside, provide most occupants with the desired level of protection. Any set of window bars, even fixed bars, can be defeated by a determined criminal attack. However, such an attack will be either noisy or time consuming, and may not be attempted by burglars seeking easy targets of opportunity.

Up to now there has not been any interest expressed to UL by manufacturers, homeowners groups or insurance companies for these systems to provide a minimum level of resistance against an external forced attack, as quantified by a published test standard.

UL has numerous standards for burglar resistant equipment that are relied upon by insurers and businesses for setting minimum levels of attack resistance for devices such as safes, vault doors, ATMs,

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and burglary resistant glazing. However, due to lack of insurance or other demand in establishing specific levels of attack resistance for window bar releasing systems, this area of performance is not included in the draft construction and performance requirements. To clarify this limitation, the term 'burglar bars' or 'security bars' are rarely used in this report, in favor of the more accurate term 'window bars', which does not include a specific security connotation.

The expectations of the equipment buyers will dictate the level of protection provided by the window bars and releasing system. Systems that appear to be flimsy or easily manipulated and defeated from outside the dwelling will not be purchased. A Secure Attachment Test is included in the draft requirements to determine if the window bar system can be securely mounted to the test frame, so it will resist a 50 lb. pull without opening or loosening in the test frame. However, this test is not intended to evaluate the relative attack resistance of the system. If a need for evaluating the attack resistance of these systems is indicated, additional consideration toward establishing such requirements will be made.

2. Rescue Operations

The presence of window bars on residential dwelling windows, even those with internal releasing assemblies, will prevent or delay entry into the dwelling by potential rescuers in the event of a fire in the dwelling. Rescuers may include neighbors or emergency responders (e.g. fire fighters) who are attempting to open or remove the window bars in order to perform rescue operations. Tragically, in many fires the 'first on scene' rescuers; neighbors, police and fire fighters; were unable to remove the bars to rescue occupants trapped inside by the bars.

Photo courtesy of *American Fire Journal*

By their very nature window bars, even those including interior releasing systems are expected to keep a potential burglar from easily opening or removing the bars from the outside of the building. Unfortunately this attack resistance also keep 'good neighbor' rescuers and emergency responders out, or at least delay their ability to remove the obstruction in a timely fashion.

Features could conceivably be provided to allow emergency response personnel to quickly release the bars, using components such as integral lock boxes on the bars, that can be unlocked with master keys carried on the fire apparatus. Although this is a possible solution, it adds a significant cost to the price of the window bar system.

There are currently thousands of homes in the U.S. today that are protected with window bars with no release mechanisms. In order to get these to be replaced with units with interior release systems, the cost of the systems must be kept at a reasonable price, according to the NFPA Center for High Risk Outreach, Home Security and Fire Safety Task Group.

Input received from fire service representatives suggests that with proper training firemen can quickly force entry through window bars during fire conditions using tools carried on the fire apparatus. The methods to do this vary from department to department, and include forced attacks using sledgehammers, pry bars, power saws and pneumatic rescue tools.

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Many fire service representatives also acknowledged that they understood that in these high crime areas residents and society would not tolerate the complete removal of window bars, or consider installing releasable window bar systems unless they were affordable and offered an acceptable degree of physical security. We were specifically advised that occupants may not allow releasable bar systems with provisions for a fire department master key to be installed, for fear that the key may fall into the wrong hands. The overwhelming direction provided to UL by the fire service was to develop requirements for the systems that allowed the occupants to quickly release the bars from the inside of the home, and escape through the opening created. They[4] did not feel that it was necessary to include provisions requiring the bars to be removed or opened quickly by emergency response personnel.

Based on this input and rational, the draft requirements in Appendix B do not require external keyed locks or other mechanisms to be provided to assist emergency responders in opening the window bars from the outside. However, nothing in the draft requirements would prevent such features from being provided on a system. UL reserves judgement on this particular scoping issue, pending receipt of additional information.

3. Cost Effectiveness

In order to be an acceptable alternative to low cost fixed window bars, systems with releasing mechanisms must be competitively priced. Local jurisdictions in the San Francisco Bay area have found that window bars with releasing mechanisms can be installed by a licensed contractor on a typical window for approximately $ 300 to $350 per window, including labor. This price is partially based on agreements reached with manufacturers and local installers to retrofit a large number of windows in the city. Prices may be slightly higher otherwise.

To be practical, a standard used to investigate and List window bar releasing systems must allow reasonably priced products to comply with the requirements in the standard. If the requirements in the standard are so rigorous that the cost of Listed products becomes excessive, then the market will not support the widespread use of releasable window bars, and the standard will be ineffective. What is needed is a standard that includes an acceptable minimum level of reliability for the products, without adding too much additional expense to manufacturing or installation costs.

4. Component versus System Certification

If acceptable requirements are developed to investigate and list (certify) window bar releasing systems, it will be necessary to determine if the entire system, including window bars and releasing mechanism will be certified in its entirety, or whether just the releasing mechanism will be listed. This decision will be based on market factors and the needs of the authority having jurisdiction and certification agency. Consider the following situations.

[4] This input was received from fire service representatives at various meetings including the 1998 NFPA annual meeting in Cincinnati, the 1998 UL Fire Council meeting, and the ICBO Peninsula Chapter meeting in Milpitas, and the April 22, 1999 ad hoc meeting at San Ramon Fire Protection District headquarters. This direction was provided by members of the National Association of Hispanic Firefighters, International Association of Black Fire Fighters, Oakland, CA Fire Department, Ft Lauderdale, FL Fire Department, and the Massachusetts and California State Fire Marshals' offices. It was also confirmed in a letter from the National Association of State Fire Marshals.

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Equipment Certification Possibilities

System Make-Up	Certification Marking
Situation 1 – The entire system (bar assembly and releasing system hardware) is packaged together.	A single certification (listing) mark on the latching mechanism seems appropriate.
Situation 2 – A manufacturer produces window bar assemblies and releasing system components, and markets them in separate packages. This allows the buyer to: (a) Obtain a bar assembly that fits various sized windows. (b) Select either fixed mounting hardware, for windows that do not require releasing systems, or releasing system hardware, for windows in the secondary means of escape path. A buyer placing bars on all windows of a home will probably have a mixture of fixed and releasable mounting hardware. (c) Select the type of actuator to be used on the releasing systems.	A single certification (listing) mark on the latching mechanism seems appropriate. In this case the combination of releasing system components, bar assemblies and mounting hardware can be evaluated and tested by the certification agency. Bar assemblies that are found to be suitable for use with the releasing system can be referenced in the installation instructions by manufacturer's name and model number and maximum dimensions.
Situation 3 – A manufacturer provides a releasing system for use with a bar assembly fabricated by others.	A single certification (listing) mark on the latching mechanism may be appropriate. In this case the combination of releasing system components, bar assemblies and mounting hardware can be evaluated and tested by the certification agency. Bar assemblies that are found to be suitable for use with the releasing system can be referenced in the installation instructions by maximum dimensions and/or weight. The manufacturer's name and model numbers should also be included, especially if the bar assemblies are under a factory follow-up inspection program.
Situation 4 – A manufacturer provides a bar assembly for use with a releasing system fabricated by others.	Under these conditions it is not possible to ensure that the bar assembly will be used with an appropriate releasing system. In fact the assembly may be used with fixed mounting hardware. The appearance of a certification mark on a bar assembly that may be secured with fixed mounting hardware may provide a false feeling of safety to the buyer or home owner, and does not seem appropriate.

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It is appropriate to mark individual system components with the manufacturer's name and model numbers, and date of manufacturer to be able to track different production runs. Markings on the actuators should include symbols or diagrams showing how to operate the system.

Detailed instructions should be provided with each releasing system describing how to install, operate, test and maintain the system.

VI. SUMMARY

This research project was conducted to obtain information about window bar releasing systems, the factors associated with their reliable operation, and to determine if a Standard for Safety could be developed to cover the construction and performance of these systems.

An examination of window bar releasing systems currently on the market, along with findings on installation, maintenance, testing and use issues raised significant questions about the ability of these systems to operate consistently and reliability during the anticipated life of the systems. Several potential failure modes were identified that could prevent the occupants from being able to escape from windows protected by releasable window bar systems.

Initial acceptance testing of window bar releasing systems in the presence of local building or fire officials would help alleviate some of the potential failure modes associated with improper installation. Periodic testing, maintenance and repair of the releasing systems are also needed to reduce the potential failure modes to an acceptable level.

Meeting with fire officials, building officials, manufacturers and safety experts indicated that a standard for evaluating window bar releasing systems should focus on the ability of the system to quickly and consistently allow the occupant to disengage the bar assembly so an escape through the window was possible. The consensus of those questioned indicated that it was not necessary to develop requirements to evaluate the level of security provided by the window bar releasing assembly.

It was also the consensus of those questioned that it was not necessary to include requirements in the standard to evaluate the ability of emergency responders to quickly gain access through the bar assembly during rescue operations. UL reserves judgement on this particular scoping issue, pending receipt of additional information.

Several state agencies and local authorities having jurisdiction have contacted UL for assistance in their efforts to develop safety standards for window bar releasing system regulations. In the interest of providing a foundation for these regulations, a draft set of construction and performance requirements, which do not include an evaluation of emergency responder ingress, is included as Appendix B. It is anticipated that the agencies and jurisdictions will review the information included in this report, examine the concerns expressed with the systems, and develop a comprehensive set of regulations based on this initial work and their own findings.

If the issues presented in these findings are addressed as a result of further research and information received from interested parties, UL may proceed with the development of a Standard for Safety for window bar releasing systems.

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APPENDIX A

Releasing Systems for Window Bars - Sample Examination and Analysis

Purpose

On April 27, 1998 and September 22-23, 1998, seven window bar releasing systems were examined at the State Farm Fire and Casualty Insurance Company Research Facility in Bloomington, IL. Members of UL's Engineering Services, Research and Regulatory Services Departments were present for the sample examination, in addition to State Farm staff.

The main purpose of this investigation was to evaluate a variety of different window bar releasing systems. The investigation included a sample examination, operation evaluation, and determination of potential product failure modes. Limited testing of the systems was performed, as noted below. An limited evaluation of the staff's perceptions of acceptable opening forces was performed, as summarized in the body of this report. The testing performed and observations made should in no way be considered to reflect compliance (or non-compliance) with any present or future established requirements for window bar releasing systems. The main focus of the investigation was to determine the ability of the releasing systems to be operated by potential occupants. An analysis of the systems' attack resistance, ability to be removed from the mounting structure by emergency response personnel during rescue operations, or the potential for head entrapment was not conducted.

Test Specimens - State Farm personnel purchased the test specimens from suppliers located around the United States based on general guidelines provided by UL. For test and analysis purposes, State Farm mounted each window bar system over a wood framed window opening with no window in place. The inner and outer wall coverings consisted of a gypsum board and plywood respectfully, mounted on a two by four wood stud frame. The smooth surface afforded by this type of construction is representative of an interior wall. However, it is not necessarily representative of an exterior wall. The rough and possibly uneven surfaces of an exterior wall covered with brick, stone, shingles, stucco, siding, and other materials may increase the level of difficulty to properly align the window bars and release mechanism hardware during installation. During our evaluation it was observed that misalignment of the window bar assembly with respect to the latching mechanism frequently increased the level of effort required to operate the system and in some cases prevented release altogether.

We examined seven different window bar releasing systems that were operated by:

- Finger (pressing, pushing or pulling)
- Hand/Arm (rotating a lever arm)
- Foot (pressing on or kicking a pedal, stepping in a stirrup)

Interior and Exterior Systems - Two of the window bar releasing systems examined were designed for interior mounting. The bar assemblies for these systems swing into the room when the system is actuated. One system examined mounts inside the window in the window frame, and includes a removable bar escape system. The remaining four window bar releasing systems examined were designed to be used with externally mounted window bars. Once released, the bars swing outward. The hinges, latch, catch and bar assembly of the exterior mounted systems are exposed to the elements after installation. The long term effects of this exposure to sun, rain, snow, blowing dust and other environmental conditions was not determined as part of this three day evaluation.

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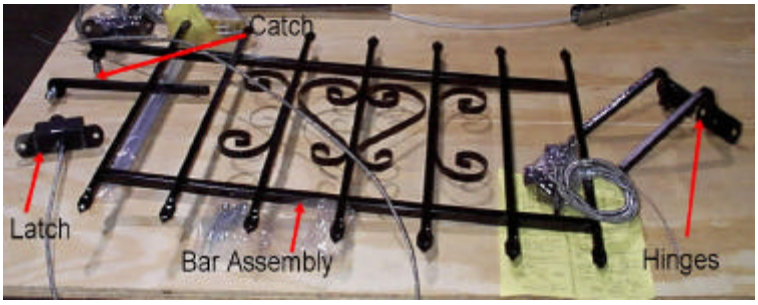
Sample 1



Modular Bar System

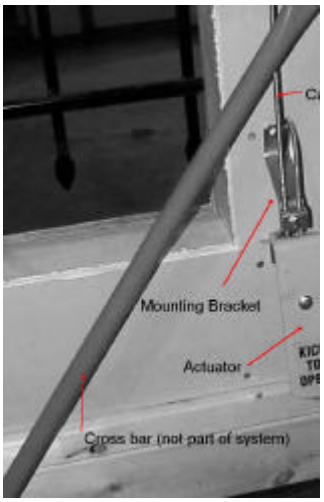
Description: Modular system provided by a single manufacturer. The system tested consisted of two hinges mounted on "L" brackets, two locking bullets (catches) mounted on "L" brackets, two latch mechanisms, two cables and a foot operated actuator with its own mounting bracket. Hinged "L" brackets and locking bullet "L" brackets are inserted into hollow channels in the window bars as shown. Window bars are made of square extruded hollow steel stock. They may be purchased directly from the manufacturer or distributor. Exterior mounted bars swing outward.

Latch: Two spring-loaded latches employing shutter mechanisms are affixed to the exterior wall of the building. Each shutter mechanism engages an annular groove on the locking bullets.

Actuator and Mounting

Actuating Mechanism: Each spring loaded latch is provided with a cable that connects to the actuator. This cable is fed from the outside of the building to the inside through a hole drilled in the wall. The cable is routed across the interior of the wall to a bracket supported foot pedal actuator mounted near the floor, remote from the window opening. Kicking this foot pedal pulls both cables and causes both shutter halves in each latch to retract. A sharp kick is more effective at disengaging the latches than a steady foot applied force. Once the locking bullets are disengaged from the latches, the window bars may be swung outward. A coil spring surrounding the bullet is intended to cause the window bars to move sufficiently to clear the locking mechanisms as soon as the bullets are released.

An alternate "stirrup" actuator may be attached to the cables and substitute for the foot pedal. The stirrup is held away from the wall by a mounting bracket that allows the cables to be pulled by stepping into the stirrup.



Actuator Installation

Testing: A 25 lb. weight was hung from the top of the window bars above the latching mechanism to simulate misalignment of the bar assembly due to improper installation or structural settling. With this weight applied, the window bar release actuated on 10 repeated kick trials.

Advantages: Maximum force can be exerted by a kick. Stepping into the optional stirrup can exert almost full body weight force. The release actuator is mounted remotely from the window, making it difficult to operate the release mechanism from the outside by reaching through an open (or broken) window.

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Disadvantages: Each operating cable is provided with an outer sheath and must be cut to the appropriate length. Broken or cut individual cable strands may result in the cable binding within the outer sheath. Improper routing of the cables may also cause them to bind and increase the force required to operate the latch mechanism. The shutter release mechanism of the latch is designed such that it must retract at two places (top & bottom) in order to release the locking bullet. Improperly adjusted cables may not provide sufficient travel to completely open the shutters and release both locking bullets. The setscrew securing the cable to the actuator must be properly tightened or the cable will slip within the connection and the latch cannot be disengaged. If the springs within the latch are not of sufficient strength to push the bars clear of the latch shutter, the bars will not disengage from the latch unless continuous pressure is concurrently exerted on the foot actuator while the bar assembly was pushed outward. This simultaneous double-action was not found to be an intuitive motion for the researchers present. The latch mechanisms and hinges are designed to be mounted on the exterior of the building, thus exposing them to the elements.

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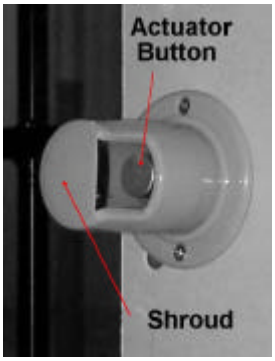
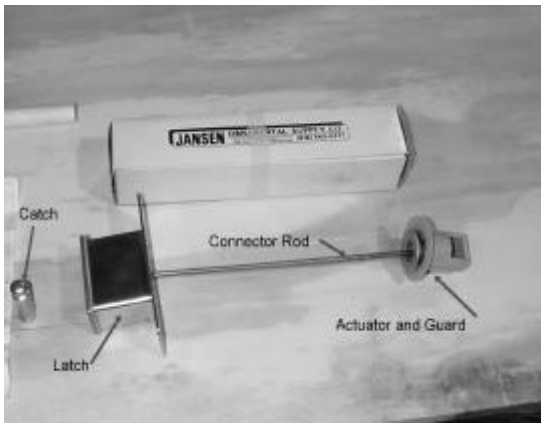
Sample 2

Description: Push button actuator provided as a stand-alone product by the manufacturer or distributor. A local ornamental metal fabricator must custom weld a window bar and hinge assembly for use with the hardware release kit. The locking bullet (catch) is secured to an external bar assembly with a screw, which may then be welded in place. Bars swing outward. Per the manufacturer's installation instructions, one actuator is to be used with each window bar. The window bar system installed at State Farm used two release mechanisms, one each at the top and bottom cross bars.



Latching Mechanism: The spring-loaded latch engages an annular groove in the locking bullet (catch) that is permanently secured to the window bars.

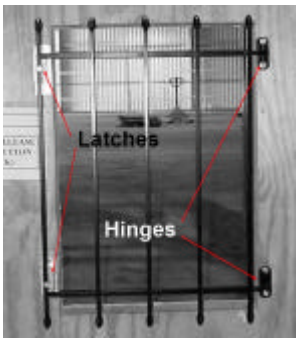


System Components

Actuating Mechanism: Depressing push button with finger moves a steel rod positioned through the building wall and causes the externally mounted latch to spring open, thereby releasing the locking bullet attached to the window bars. No cable is used with this system.

Testing: Under optimum operating conditions the system works well, and the actuators easily disengage the latch with approx. 5 lb. of finger applied force. However, when a 25-lb. weight was hung from the window bars at a distance furthest from the hinge to simulate settling or misalignment, the force required to unlatch the assembly increased to 43 lb. Under these conditions it was not possible for the researchers to exert sufficient finger pressure to release the 'misaligned' bars.

Advantages: The spring loaded latch design is such that the actuating mechanism does not have to be constantly activated while pushing outward on the bars. This is a desirable feature. The direct steel pin linkage between the push-button and the latch mechanism requires no adjustment after initial installation. A plastic protective cover mounted on the interior wall prevents accidental actuation of the release mechanism and also makes it difficult to operate the release mechanism from the outside when reaching in through an open window.



Exterior View

Interior View

Disadvantages: It is difficult or impossible to exert sufficient force by finger alone to release latch when the window bars are misaligned. The latch and hinges were mounted on the exterior of the building, exposing them to the elements. Having the actuator located so close to the window may encourage someone outside the home to reach in and attempt to disengage the bar assembly.

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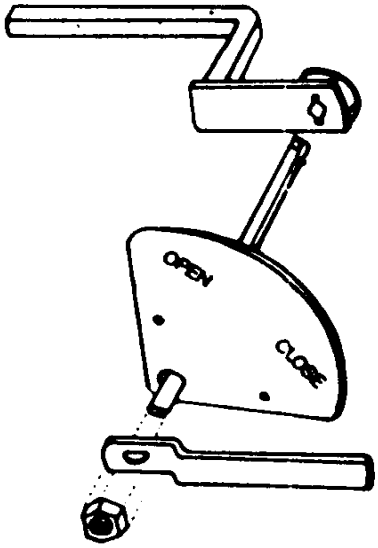
Sample 3

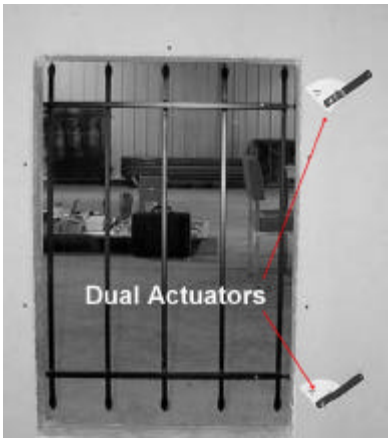


Description: Hand Operated Lever. A local ornamental metals fabricator must custom weld a window bar for use with the hardware release kit. Exterior mounted bars swing outward.

Latching Mechanism: Keyed steel rod inserted through wall engages spring-loaded key way permanently attached to the window bars. Two mechanisms were installed on the bar assembly cross bars per manufacturer's instructions.

Unlatching Mechanism: Hand lever adjacent to window rotates a keyed steel rod. When the pin on the end of the steel rod lines up with the keyed slots on the lock body mounted to the window bars, the window bars are disengaged.

Testing: Both a 25 lb. and a 35 lb. weight were hung from the window bars at a point furthest from the hinge to simulate misalignment. In both cases the window bars opened easily regardless of whether the top or bottom release mechanism was operated first.



Interior View

Advantages: Direct steel rod connects release handle actuator with latch keyway. No cable connections are required. System alignment is not a critical factor for proper system operation.

Disadvantages: Need to carefully align pin with keyway to reclose mechanism. If bars don't automatically release (e.g. broken spring, corroded hinge, etc.) it may be difficult to sense correct alignment of pin with key way in order to attempt to force the window bars away from the window opening. Latch release components and hinges mounted to exterior of building exposing them to the elements. Release actuators may be operated from the outside by reaching in through an open (or broken) window.

System Components

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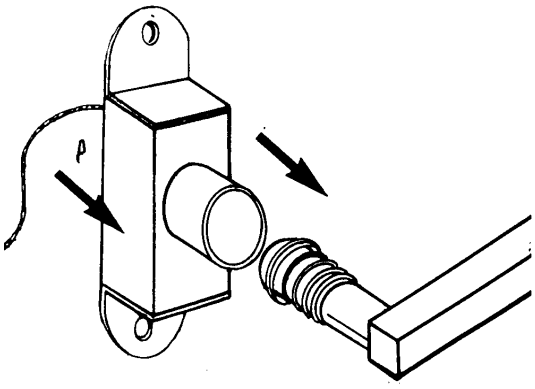
Sample 4

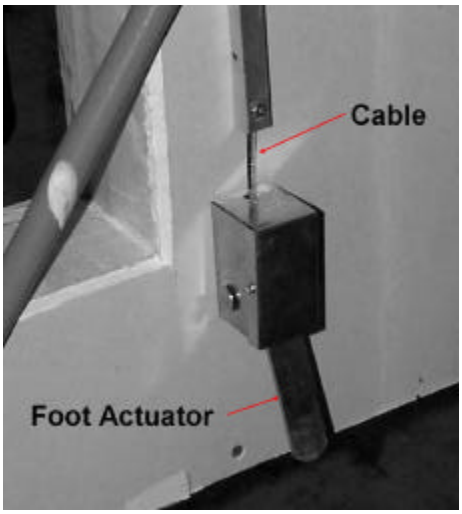


Description: Similar to System 1. A local ornamental metals fabricator must custom weld a window bar for use with the hardware release kit. Exterior mounted bars swing outward.

Latching Mechanism: Annular groove on spring loaded bullet (catch) is engaged by a spring loaded latch pin

Actuating Mechanism: Depressing (or kicking) the foot pedal pulls the cables attached to the spring-loaded latches. As the latching mechanism opens the bullet attached to the movable bar assembly is released, allowing the bars to swing outward.

Testing: A force of 17 - 27 pounds is required on the foot pedal to disengage the bar assembly. When a 25-lb. weight was hung from the top of the window bars at a point furthest from the hinge, the bottom latch disengaged but the top latch did not. With the 25-lb. weight hung from the bottom of the window bars at a point furthest from the hinge, the top latch disengaged but the bottom latch did not. The complete assembly was subjected to 300 cycles of normal operation, performed by two researchers, one on each side of the test wall. Each cycle consisted of kicking the actuator to disengage the latch, opening the bar assembly, and closing and re-engaging the latch. The system operated properly throughout the test. At the end of the test, no component damage was noted, except for a slight elongation of the cable at a point where it was routed through the foot pedal enclosure.



Advantages: Maximum force can be exerted by a kick. Actuator is mounted remotely from the window making it difficult to be operated by someone reaching in through an open (or broken) window.

Disadvantages: If a spring failure or misalignment occurs the bars don't disengage when momentary contact actuator is depressed. To disengage the latch from the movable bar assembly continuous pressure must be exerted on foot pedal or stirrup to keep both latch release mechanisms open while the bars are concurrently pushed outward. This was judged to not be an intuitive operation by the researchers. When this condition occurred the tendency of the researchers was to kick the actuator harder to disengage the latch from the bar assembly. This was not successful in releasing the bar asembly.

Latch release components and hinges mounted to exterior of building exposing them to the elements. Cables may stretch or bind, increasing the force required to operate the release mechanism. If the cable lengths are not adjusted properly, the latches may not operate properly, or only one may function and not the other. If the setscrew securing the latch to the cable slips, the system will not operate, and the source of failure will not be readily apparent to the occupant.

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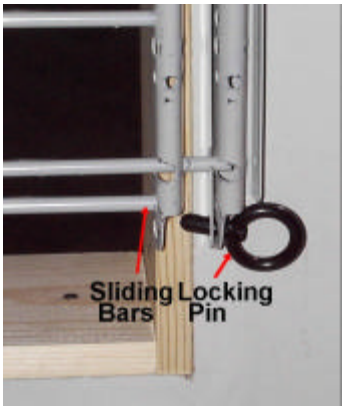
Sample 5

Description: Adjustable-width interior window bars, which open into the room. Bars constructed of solid steel rods that slide through metal brackets. The manufacturer's literature claims the product includes 'child safe 3 ½ " bar spacing". Includes holes in the movable bar assembly bracket and mounting frame that can be used to lock the bars shut with a padlock.

The manufacturer's literature describes four mounting arrangements as follows:

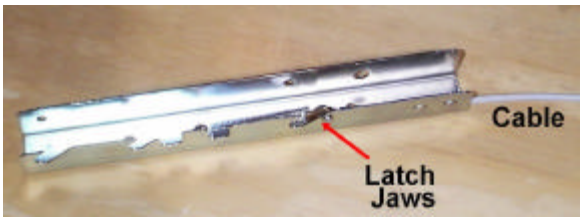
- A fixed (non-opening) arrangement where the bar assembly is secured with 3" screws.
- A nut and bolt arrangement that effectively prevents the bars from opening.
- A padlock mounting arrangement, where it is recommended to "hang key nearby for safety".
- A remote hand operated actuator and latching mechanism is sold separately, and includes an integral five ft. cable



The basic system we examined is provided with a plastic pin that is inserted through holes on window bars and window bar frame. Removing the pin allows the bars to swing inward. This is not a viable means of protection that would be used by an occupant, since a burglar can easily reach in the window between the bars and pull it out. Unless the remote actuator/latch kit is purchased, there is no means (other than the pin) provided for releasing the bar assembly. A limited evaluation of the remote actuator was made, which showed it to operate consistently, but with many of the same problems as other cable connected actuators.

Advantages: Interior mounting - Easy to install on a smooth interior wall. Less exposure to the elements than an exterior system.

Disadvantages: Occupants buying the basic system do not have a viable releasing system, and may not initially realize this. The padlock and nearby key system does not provide a code complying releasable system, since it requires the use of a key to operate. The aligned holes (hasp) in the bar assembly/mounting bracket make it extremely easy for the occupant to padlock or bolt the bars in place so they cannot be released.



Latching Mechanism

Actuator

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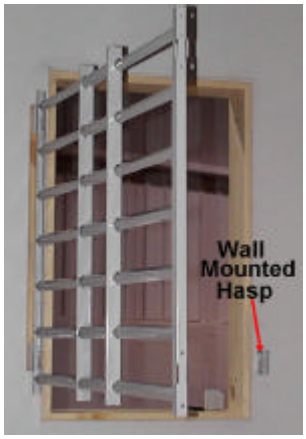
Sample 6

Description: Adjustable-width interior window bars, which open into the room. Bars constructed of flat steel bars (angle iron) that slide through metal brackets. Same manufacturer as Sample 5. Manufacturer's literature claims flat bars resist bolt cutters. The manufacturer's literature describes four mounting arrangements as follows:



- A fixed (non-opening) arrangement where the bar assembly is secured with 3" screws.
- A nut and bolt arrangement that effectively prevents the bars from opening.
- A padlock mounting arrangement, where it is recommended to "hang key nearby for safety".
- A remote hand operated actuator and latching mechanism is sold separately, and includes an integral five ft. cable

The basic system we examined is provided with a plastic pin that is inserted through holes on window bars and window bar frame. Removing the pin allows the bars to swing inward. This is not a viable means of protection that would be used by an occupant, since a burglar can easily reach in the window between the bars and pull it out. Unless the remote actuator/latch kit is purchased, there is no means (other than the pin) provided for releasing the bar assembly. A limited evaluation of the remote actuator was made, which showed it to operate consistently, but with many of the same problems as other cable connected actuators.

Advantages: Interior mounting - Easy to install on a smooth interior wall. Less exposure to the elements (e.g. rust, corrosion, ice, etc.) than an exterior system.

Disadvantages: Occupants buying the basic system do not have a viable releasing system, and may not initially realize this. The padlock and nearby key system does not provide a code complying releasable system, since it requires the use of a key to operate. The aligned holes in the bar assembly/mounting bracket (hasp) make it extremely easy for the occupant to padlock or bolt the bars in place so they cannot be released.

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Sample 7

Description: System consists of top and bottom mounting brackets. Individual round steel bars are secured in holes in top and bottom brackets. A steel latching plate in the bottom mounting assembly secures catch tabs on bottom end of window bars, holding them in place. A key and lock were provided on the sample, although a cable and remote actuator assembly was reported to be available, and would replace the key and lock. The entire assembly mounts in a window frame, on the interior side of the glass.

System with Bar Removed

System Operation: When the lock is unlocked, or the actuator is depressed, the steel latching plate is moved to a position that no longer retains the catch tabs on the bottom of individual bars. The bars can then be removed by lifting them from the bottom-mounting bracket, one at a time. Several bars must be removed to create an opening of sufficient size for escape.

Advantages: The assembly is mounted inside of the window, reducing the exposure to the elements (e.g. rust, corrosion, ice, etc.) than an exterior system.

Disadvantages: The lock and key feature is not a code complying solution. The amount of time, effort and manual dexterity needed to disengage the latch plate and individually remove enough bars to create an escape sized opening was not determined during this limited investigation.

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APPENDIX B

Draft Construction and Performance Requirements for Releasing Systems for Window Bars

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FOREWORD

Many factors must be present for window bar releasing systems to operate properly during a fire or other emergency. The equipment must be in operable condition, and must be able to be operated by the occupants to escape through the window. By their very nature, window bar releasing systems installed in dwelling units are not usually operated as part of the occupants' daily living routine. A loss of function of these systems may not be quickly discovered by the occupant since the systems are rarely operated. In addition to possible equipment failures, occupants must be able to operate the systems in emergency situations, which requires them to be familiar with their location, purpose and operation. Any user operable mechanical system that normally remains in an inactive state cannot be expected to operate consistently and reliably over its intended lifetime without periodic operational testing by the intended user.

Without some means of assuring that the dwelling's occupants will periodically operate and inspect the systems, it cannot be assured that systems, even those complying with these requirements, will operate when needed during a fire or other emergency condition. This risk can be significantly reduced if the local authority having jurisdiction or other responsible party has a program in place to assure ongoing inspections, testing and maintenance of the systems

If such a program is implemented, and was actively enforced by a responsible party, the following provides a basic level of construction and performance requirements for window bar releasing systems.

INTRODUCTION

1 SCOPE

1.1 These requirements cover releasing systems for bars, grills, mesh, glazing or other items covering windows in residential dwelling units. When actuated by the occupant, the system allows the obstructions over the window to be moved so occupants can escape through the window in the event of an emergency.

1.2 These requirements only cover the ability of the releasing system to be able to be manually activated from the interior of a residential dwelling unit by the occupant to effect an escape through the protected opening.

1.3 These requirements cover releasing systems intended for use on the interior side of windows in all climatic locations. These requirements also cover releasing systems intended for use on the exterior of the window in locations not subjected to accumulation of ice, snow, or blowing dust.

1.4 These requirements do not evaluate the ability of the releasing system or window obstructions to resist an external forced entry attack.

1.5 These requirements do not evaluate the ability of the releasing system or window obstructions to allow window bar releasing systems to be opened or removed from the exterior of the residential dwelling unit by emergency response personnel during rescue operations.

1.6 Products covered by these requirements are intended for installation in residential dwelling units to protect window openings which are designated by building codes to be used as the secondary means of escape from the living area. These codes include the *Life Safety Code*, *NFPA 101*, published by the National Fire Protection Association, the *National Building Code*, published by the Building Officials and Code Administrators International, the *Uniform Building Code*, published by the International Conference

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of Building Officials, the *Standard Building Code*, published by the Southern Building Code Congress, International, the CABO *One and Two Family Dwelling Unit Code*, the *National Building Code of Canada,* published by the National Research Council of Canada, and the *International Building Code* and *International Residential Code* published by the International Code Council.

1.7 Products covered by these requirements are not intended to be used to protect doors in the means of egress path for nonresidential occupancies, the common egress path of multifamily residential dwelling units, or the primary means of escape path in a family dwelling unit.

1.8 These requirements do not cover window guards or fall prevention devices that are intended to prevent falls from upper story windows.

1.9 These requirements do not apply to storm windows or light duty screens used for insect control.

1.10 A product that contains features, characteristics, components, or materials new or different from those covered by these requirements, and that involve a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain an acceptable level of safety.

2 GENERAL

2.1 Components

2.1.1 Except as indicated in 2.1.2, a component of a product covered shall comply with the requirements for that component.

2.1.2 A component need not comply with a specific requirement that:

a) Involves a feature or characteristic not needed in the application of the component in the product covered by these requirements, or

b) Is superseded by these requirements.

2.1.3 A component shall be used in accordance with its recognized rating established for the intended conditions of use.

2.1.4 Specific components are recognized as being incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specific limits, and shall be used only under those specific conditions for which they have been recognized.

2.2 Units of measurement

2.2.1 When a value for measurement is followed by a value in other units in parentheses, the first stated value is the requirement.

2.3 Undated references

2.3.1 Any undated reference to a code or standard appearing in these requirements shall be interpreted as referring to the latest edition of that code or standard.

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2.4 Installation instructions

2.4.1 A copy of the operating and installation instructions or equivalent information is to be furnished with the samples submitted for investigation for use as a guide in the examination and test of the mechanism. For this purpose a printed edition is not required.

2.5 Definitions

2.5.1 Dwelling unit - A single unit, providing complete, independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking, and sanitation.

2.5.2 Escape - For the purposes of these requirements, escape refers to movement of occupants from the interior of a residential dwelling unit to a safe point outside of the dwelling unit during an emergency fire condition.

2.5.3 Means of Escape. A concept included in building codes that, in most cases, requires sleeping rooms and living areas in dwelling units to be provided with at least one primary means of escape and one secondary means of escape to the outside.

2.5.4 Primary Means of Escape - A door, stairway, or ramp providing a means of unobstructed travel from living spaces inside a dwelling unit to the outside at street or ground level. It is possible to walk the entire length of the primary means of escape.

2.5.5 Secondary Means of Escape - A passage independent of and remote from the primary means of escape, that provides a means of travel from living spaces inside a dwelling unit to the outside. The secondary escape route is allowed to be through doors and stairs, or out of escape windows of specific sill heights, opening dimensions, and location with respect to the outside ground level.

2.5.6 Window bars - For the purposes of these requirements the term ‘window bars’ refers to metal and other bars, grills, grates and other barriers that are designed to cover windows in residential dwelling units. The purpose of window bars, by their mere presence on a building, is to deter a potential forced entry into the dwelling.

CONSTRUCTION

3 ASSEMBLY

3.1 Window bar releasing systems consist of the window bars, latches, manual actuators, cables, connectors, hinges and mounting hardware. The entire system shall be packaged in a single container. Standard mounting hardware including screws, bolts and washers are allowed to be provided separately.

Exception: The window bars shall be allowed to be provided separately if the instruction manual complies with section 13.2.

3.2 The system shall be of a type capable of being readily maintained in proper operating condition.

3.3 The system shall be designed to immediately unlatch the window bars when actuated. It shall be able to be operated from the inside by the building occupants without the use of tools, keys or special knowledge or effort.

3.4 The manual actuator used to release the window bars shall be designed to be mounted inside the

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dwelling unit for operation by the occupants. Covers or other barriers that can obstruct access to actuators shall not be provided if they inhibit the proper operation of the system.

3.5 The release mechanism shall not depend on springs to release the latch, although springs are allowed to be provided to assist in the operation.

3.6 The system shall be designed to prevent it from being locked in a closed position with a pad lock, or a pad lock and steel chain or cable. Hasps, eyes or similar construction shall not be provided, and the construction shall be such that the moveable portion of the system cannot be chained or locked to the nonmoveable portion of the system.

3.7 Systems provided with an automatic actuating mechanism shall also include a manual release system that complies with these requirements. The automatic actuation portion of the system, even in the event of its failure, shall not inhibit operation of the manual releasing system.

3.8 Manual actuation of the system shall release the bars quickly and with simple, easily understood and intuitive motions. The system shall be capable of being operated in all lighting conditions.

3.9 Manual actuation of the system shall not require two different forces to be applied at the same time, such as applying force to the actuator while also pushing on the bars.

3.10 When fully opened, the assembly shall provide a minimum clear opening of not less than 5.7 sq ft (0.53 sq. m) with the width not less than 20 in. (51 cm) and the height not less than 24 in. (61 cm), measured parallel to the plane of the opening.

3.11 Window bars shall be constructed so that they do not swing up to open. They shall not include projections that can easily snag the clothing of those escaping through the opening.

3.12 Window bars shall have be constructed such that a sphere 4 in. (10.1 cm) in diameter shall not pass through any opening and shall not create other potential head entrapment hazards.

4 MATERIALS

4.1 The materials employed shall have adequate mechanical strength to perform their intended function.

4.2 O-rings, gaskets and seals shall comply with UL 157. Polymeric materials shall comply with UL 746C, Section 25-27.

Exception: O-rings, gaskets, seals and polymeric materials that are used as decorative parts, or whose failure will not affect the ability of the system to comply with these requirements.

4.3 Components constructed of dissimilar metals shall not be used in applications where contact between them is likely to cause galvanic corrosion. The materials employed shall reduce the likelihood of the release mechanism becoming inoperative due to corrosion.

4.4 Ferrous metal parts shall be 300 series stainless steel or protected against corrosion using minimum G60 or A60 hot-dipped mill galvanization, 0.0104 mm thick zinc coating, 0.0127 mm thick cadmium coating, or two coats of organic outdoor paint.

4.5 Manual Actuators

4.5.1 Window bar releasing assembly mechanisms shall include a manual actuation mechanism that is capable of unlatching the window bars so that they can be opened by the occupants. The actuating force

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shall be applied in one of the following manners:

Finger actuated: Pushing with the index finger or pulling a loop with the index finger in a curled position.

Hand actuated: Pulling, pushing, twisting, rotating or turning a lever, knob, handle, rod or similar actuator with the hand or multiple fingers.

Foot actuated: Kicking, depressing or stepping on an actuating pedal, lever, stirrup or similar actuator.

4.5.2 On foot actuated systems, only a single foot motion shall be used to disengage the bar assembly from the latch. On finger and hand actuated systems, one or two distinct hand or finger motions shall be used to disengage the bar assembly from the latch.

4.5.3 Releasing the actuator after the latch has been disengaged from the bar assembly shall not reengage the bar assembly.

4.5.4 No features or methods shall be provided or referenced in the instruction manual to inhibit the operation of the releasing mechanism.

4.6 Cables and Connectors

4.6.1 Cables connecting actuators to latches and release mechanisms shall only be used in applications where the force transmitted by them during normal operation is less than 1/10 the manufacturer's rated working tension or compression.

4.6.2 Cables and connectors shall not be damaged, or have wire strands frayed during normal installation or use, and shall not contact sharp objects when installed as intended.

4.6.3 The means used to secure cables or connectors to latches, release mechanisms and actuators shall provide a tight, reliable nonslip connection.

4.7 Hinges

4.7.1 Hinges shall operate smoothly and reliably, and shall not be susceptible to rust or corrosion.

PERFORMANCE

5 TEST SETUP AND SAMPLE PREPARATION

5.1 Sample Selection

5.1.1 Representative samples of the releasing system shall be assembled to a test fixture as described in the installation instructions, unless otherwise noted in specific tests. The assembly shall include the mounting hardware, releasing mechanisms, and fasteners recommended in the instructions.

5.1.2 Samples to be tested shall include each type and sizes of releasing system shown in the installation instructions. Each type of releasing mechanism shall be subjected to the complete test program, unless it can be shown that tests on one type of mechanism are representative of the worst case testing on another mechanism. The sample shall be tested with mounting hardware and window bars that represent the worst case conditions of use. This shall be considered to be the bars with the heaviest weight, greatest dimensions, and systems that create the greatest torque, moment and frictional forces on the hinges and releasing mechanism.

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5.1.3 The test report shall document the systems tested, along with the basis for sample selection.

5.2 Test Fixture

5.2.1 The test fixture in which the assembly is mounted shall consist of the wood stud construction described in 5.2.2. Systems which require a specific mounting arrangement not represented by these test fixtures, such as masonry or brick shall be mounted in a fixture of equivalent dimensions and rigidity, as described in the installation instructions. If agreeable to the testing laboratory and manufacturer, the wood stud fixture shall be representative of all mounting structures, provided the system is securely held in place in the fixture during all tests.

5.2.2 The entire test fixture shall be constructed of commercially available two by four trade size wood stud (nominal 1.5 in. by 3.5 in.) construction with vertical studs spaced on maximum 16 inch (406 mm) centers. The window opening shall be framed with two by four top and bottom plates and minimum two layers of two by four sills and headers around the window opening. Cripple studs shall be provided under the opening. The frame shall be secured in place so it does not move when the system is subjected to the test forces noted below. The frame shall extend a minimum of 12 inches (305 mm) above and on each side of the opening.

5.2.3 Actual windows and frames shall not be required to be mounted in the opening unless the presence of such windows or frames affects the operation of the system, or unless part of the system is mounted on the window or frame.

5.2.4 The exterior side of the assembly shall be covered by 3/4 inch (19 mm) thick trade size type CDX plywood, secured with minimum 1-1/2 inch (38 mm) nails or screws, secured at least every 12 inches (305 mm) to each stud, sill and header. The interior side of the assembly shall be covered with a layer of 1/2 inch (13 mm) gypsum wallboard, secured with minimum 1-1/4 inch (32 mm) nails or screws at least every 12 inches (305 mm) to each stud, sill and header.

5.2.5 Openings in the test fixture shall be sized to accommodate the size of the assembly under test, as described in the installation instructions. Opening size shall be allowed to vary if the size used is judged to not affect the results of any test performed.

5.3 Sample Assembly

5.3.1 Samples of the releasing system shall arrive at the test site in the packaging anticipated for distribution and sale, and accompanied by the installation instructions. The samples are to be installed on the test fixture by a representative of the certification organization, using common hand and power tools as recommended by the instruction manual. Any specialty tools required for assembly shall be so identified in the instructions.

5.3.2 When multiple tests are required on an assembly, they are allowed to be performed on the same test fixture, provided that new hole or openings are used for mounting. Portions of the test fixture shall be allowed to be replaced to accommodate new mounting holes or brackets.

5.3.3 Samples which include grease, graphite, silicon or other lubricants shall also be tested with the lubricant removed or not applied.

5.3.4 When assembled in accordance with the installation instructions the system shall be securely held in place in the test fixture, and shall operate consistently in the intended fashion.

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6 SECURE ATTACHMENT TEST

6.1 Two samples of the system shall be subjected to the following test sequence.

6.2 The system, when in the closed position, shall resist a 50 lb. (220 N) force without opening, loosening in the test fixture, or damaging the releasing assembly. The force shall be applied on the exterior side of the test fixture in a location that is most likely to move or damage the system. The force shall be gradually applied perpendicular to the opening and held for a period of one minute. A 3/8 in. (10 mm) diameter rope looped through the window bars, or similar arrangement shall be used to apply the force.

7 OPERATION TEST

7.1 Following the Secure Attachment Test, each of the two samples of the system shall unlatch immediately without intentional delay during each of ten attempts to operate the system, and the window bars shall be fully opened to create the opening specified in section 3.8. During each attempt the actuating mechanism shall be operated as intended, using a finger, hand or foot movement as described in the operating instructions provided to unlatch the window bars. The window bars shall then be opened to the full open position, and the system shall then be reset to the closed position. An examination shall be performed to verify that the window bars are completely reset prior to the next attempt.

7.2 Springs provided in the latch or on the bars that are intended to move the bars from the latched position shall be removed or disabled prior to the test.

7.3 Prior to the test, the assembly shall be operated and reset a number of times to acquaint the operator with the system and its opening and resetting operation. On some systems it may be necessary to slam, tap or otherwise carefully align the window bars in the latch to successfully reset the system into the closed position.

7.4 In the event that the actuating mechanism or assembly does not operate as intended during each of the ten attempts, the test assembly, mounting method, actuating motion, and system resetting procedure shall be reviewed to determine a potential cause of failure. After correcting any identified problems, the set of ten operations shall be repeated with no unsuccessful attempts.

8 MANUAL ACTUATION TEST

8.1 Following the Operation Test each of the two sample assemblies shall be operated five times and the forces required to unlatch the system shall be measured and recorded. These forces shall not exceed the values indicated in 8.2 through 8.4.

8.2 A force gauge shall be used to apply the actuating force. The force shall be applied in the orientation anticipated by the design, using an appropriate force gauge and attachments, such as hooks, loops or probes. The gauge shall be capable of measuring the maximum force applied on each attempt. The force shall be applied in a location and fashion that is most likely to unlatch the actuator, and shall be allowed to range from a slow gradual application of force, to a faster application of force of not less than one second in duration.

8.2.1 The average force required to unlatch finger actuated systems shall not exceed 5 lbs. (22 N) over the five attempts. The force required to unlatch the system during any of the attempts shall not exceed 10 lbs. (44N).

8.2.2 The average force required to unlatch hand actuated systems shall not exceed 5 lbs. (22 N) over the five attempts. The force required to unlatch the system during any of the attempts shall not exceed 10 lbs.. (44N).

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8.2.3 The average force required to unlatch foot actuated systems shall not exceed 15 lbs. (66 N) over the five attempts. The force required to unlatch the system during any of the attempts shall not exceed 30 lbs. (132 N).

8.3 In lieu of complying with Section 8.2, foot actuated systems designed to be operated by a kick shall successfully unlatch and disengage the latching mechanism each of five times when subjected to the following impact. The impact shall be applied by swinging a 25 lb. (11.4 Kg) weight on a four foot (1.2 M) pendulum from ten inches (254 mm) away, measured horizontally. The point of impact on the foot actuator shall be at the bottom of the pendulum swing.

8.4 Once the system is unlatched, a maximum force required to set the bars in motion shall not exceed 30 lbs. (132 N) and the maximum force required to open the bars to the minimum required width shall not exceed 15 lbs. (66 N).

9 ENDURANCE TEST

9.1 A sample of the window bar releasing system shall function as intended during 250 cycles of operation without failure or excessive wear of the parts, including severing or fraying of individual cable wires. Following the cycling the system shall be subjected to the Operation Test.

9.2 The system shall be operated and reset as described in the manufacturer's operating instructions. As part of the cycling, it is only necessary to unlatch, disengage and reset the system, and not open the window bars to the full open position. The cycling rate shall not exceed 30 cycles per minute.

10 ENVIRONMENTAL EXPOSURE TESTS

10.1 After each of the following exposures, test assemblies shall be subjected to the Manual Actuation Test. The test shall be performed while the test assemblies are in the test chambers, or immediately after their removal from the test chamber. Opening forces after these conditionings shall not exceed the values shown in section 8.2 or 8.3. A single sample shall be subjected to each exposure. The same sample, or different sample shall be allowed to be used for each exposure condition.

10.2 Elevated Ambient - Samples shall be conditioned in a 120 F (49 C) environment for 24 hours.

10.3 Low Ambient - Samples shall be conditioned in a minus 32 F (0 C) environment for 24 hours.

10.4 Humidity Test – Samples shall be conditioned for 24 hours in moist air having a relative humidity of 85 +/- 5 % at a temperature of 32 +/- 2 degrees C.

11 ABUSE TEST

11.1 A sample shall comply with the Manual Actuation Test requirements in sections 8.2 and 8.3 after being subjected to the simulated abuse provided in 11.2.

11.2 The sample shall be subject to six impacts of 5 ft-lb. each applied with a 2 inch diameter (51 mm) steel ball on portions of the release system that are most likely to adversely affect the operation of the system.

MARKINGS AND INSTRUCTIONS

12 MARKINGS

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12.1 Window bars and the latching mechanism shall be permanently marked with the company name, model number and date of manufacture. Adhesive backed labels used to provide required markings shall be suitable for the application, and shall comply with UL 969.

12.2 When a manufacturer produces assemblies at more than one factory, each such assembly shall have a distinctive marking to identify it as the product of a particular factory.

12.3 Symbols or diagrams shall be marked on the manual actuator to identify how to manually release the window bars. The diagram or symbols shall be readily visible to occupants when the assembly is mounted as intended.

13 INSTRUCTION MANUAL

13.1 Installation and operating instructions shall be provided with each system. Installation instructions shall describe how to install and initially test the system, and provide periodic testing and maintenance. Operating instructions shall be provided that include diagrams, drawing and symbols describing how to operate the system and escape in the event of a fire or other emergency.

13.2 When the releasing mechanism assembly is provided separately from the window bar assembly in accordance with section 3.1, the instruction manual shall describe the compatible window bars that have been investigated and found suitable for use with the releasing assembly. Window bars shall be identified by the manufacturer's name and model number and maximum dimensions.

13.3 The installation instructions shall include directions on mounting the actuator inside of the room, and shall recommend that it not be mounted over 60 inches (1.52 M) above the finished floor.

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