



VEKA Technical Reference Packet

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PVC Product Development

Vinyl windows and doors are made from a blend of PolyVinyl Chloride Resin (PVC) and a select blend of additives. This mixture, commonly referred to as "compound", is critical to achieving the desired processing of the window and door profiles during extrusion and fabrication and imparting long term weatherability to the finished product.

PVC (PolyVinyl Chloride)

PVC is created from a mixture of petroleum by-products and salt. Base stocks of ethylene and chlorine are combined in a polymerization process that results in a powdery substance that makes up approximately 85% of the "compound". In its purest form, PVC is susceptible to heat and therefore requires the addition of micro ingredients that supply the proper weatherability, impact resistance and durability that is required in vinyl window and door systems.

Stabilizers

Heat stabilizers are added to the PVC to prevent material degradation through the extrusion process. The weatherability of the end product is also increased allowing the window and doors to withstand the effects of solar heating. A product that lacks sufficient amounts of heat stabilizers will become weak when exposed to the hot rays of the summertime sun resulting in poor window operation or a total unit failure.

Processing Aids

This ingredient influences the melting and fusing of the material through the extrusion process. They impart an elastic "toughness" to the material and create a uniform melt strength throughout the profile. Without a processing aid, the resulting vinyl window product would be more susceptible to failure due to lack of inherent strength

Impact Modifiers

These improve the impact properties of the vinyl profiles by reducing brittleness and increasing pliability of the end product. Without the impact modifiers, the vinyl material used in the fabrication of windows and doors would be unable to withstand the harsh effects of the processes used in fabrication and susceptible to cracking or breaking during installation and operation.

Lubricants

Lubricants affect the flow of the plastic through the steel dies during the extrusion process. The lubricants allow the surface of the end product to be smooth and shiny, providing an added aesthetic appeal to every window.

Fillers

A filler generally consists of a fine powder of calcium carbonate. This ingredient influences several properties of the final product including impact strength, elasticity, shrinkage and material cost.

Light Stabilizers

These are added to prevent fading and chalking. Fading is caused by ultra violet light from the sun and results in a dull finished surface. Chalking is when a white residue forms on the surface of the window caused by the release of titanium dioxide from within the profile. Eventually, white streaks will form when rain washes this powder across a building surface. By adding a light stabilizer, the amount of titanium dioxide can be reduced in the compound preventing the unwanted leaching.

Titanium Oxide

TiO₂ is the primary pigment in vinyl formulations. It gives vinyl its brilliant white color and makes the product opaque. TiO₂ also aids in the reflection of UV rays preventing heat build up within the profile and protecting the window from solar fading.



Water Control

One of the most important functions of a modern fenestration product is to provide a home with light and ventilation without allowing the invasion of water. Even the smallest measures of water can cause tremendous damage to carpeting, furniture, flooring, walls and ceilings. When choosing an appropriate window system for use in construction or remodeling, a prime concern should be the design methods used for controlling water.

Water by itself is not a major concern. However, when combined with an accompanying wind, serious problems may result. Wind is a movement of atmospheric air and will create a pressure difference across a window. This pressure difference can force water through the seals between the operating sash. The most effective way of dealing with this force is to create a design that equalizes the pressure across a window (fig 1).

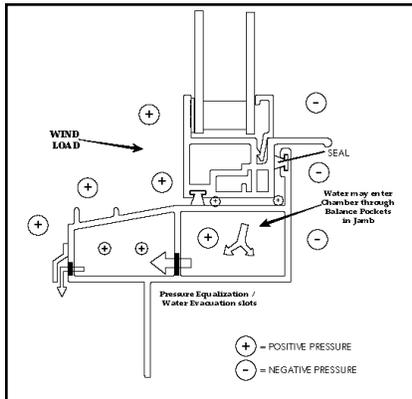


FIGURE 1: Pressure Differences and Controls in a Typical Window Sill

Generally, small slots punched into a sash or frame unit (commonly known as weep holes) serve to balance the external and internal pressures. With the pressure equalized, there is a reduction of pressure that tends to force water through the seals. Weep holes are normally baffled or protected to prevent rain from entering the window and to keep bugs and spiders from building nests or webs that may block the slot.

The pressure exerted on a window from wind increases as wind speed increases (fig. 2).

(PSF) Pressure	(IN) Water Head	MPH
.256	.05	10
1.024	.20	20
2.304	.44	30
4.096	.79	40
6.4	1.23	50
9.22	1.77	60
12.25	2.35	70
16.38	3.15	80
20.74	3.98	90
25.6	4.92	100

FIGURE 2: Pressure and Water Relationship to Wind Speed.

A 10-mph wind load on a vertical surface, exerts only about a quarter of a pound per square foot. Increase the wind speed to 100-mph, and the wind load increases ten fold (fig. 3).

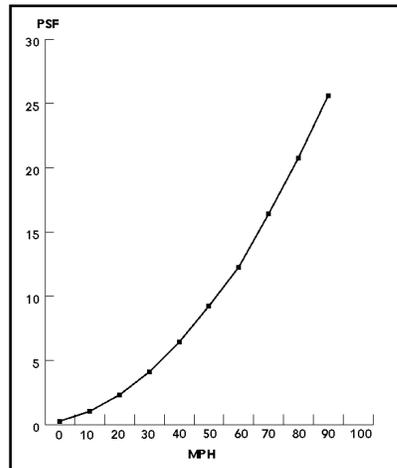


FIGURE 3

On a normal 3-0 x 5-0 window unit, the total force on the window surface from this wind will be over three hundred pounds, a serious challenge to the structural integrity of the window. But, the actual force of this wind load will also cause certain water control problems. The significance of this wind load can be explained when it is related to the "water head". The "water head" of an exerted pressure can be

described as the height a specified pressure will raise water. The water head is easily measured using a pitot tube and manometer apparatus (fig. 4).

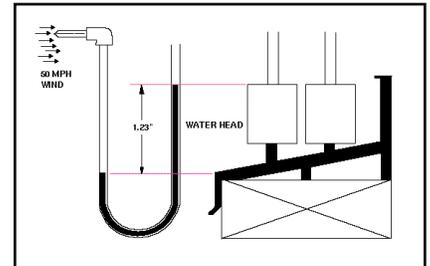


FIGURE 4: A Waterhead Manometer

As the wind pressure enters the pitot tube, it will push on the exposed surface raising the level of the water at the opposite end. The distance the water raises over its static, non-pressurized state, is known as the water head. A wind measured at 50-mph will raise the water 1.23 inches. A 100-mph wind will raise it 4.92 inches. This information is all very interesting, but how does it relate to vinyl window design. The water head of an exerted force can be a determining factor when designing a vinyl sill and its interior upstanding leg.

These elements need to have sufficient height to counteract the effects of the water head. Raising or lowering the height of these parts may drastically effect the performance of the window. Along with the water head, there are other forces involved in the movement of water through a system. Gravity, kinetic energy, surface tension, capillary action and air currents all contribute to water infiltration. These forces need to be controlled if a window is to perform one its most important functions—controlling the movement of water into the home. Incorporating proven design features in a window will have the most significant and long lasting impact on the performance of a fenestration product. Therefore, these forces need to be addressed in the early phases of system design.



Air Infiltration Testing

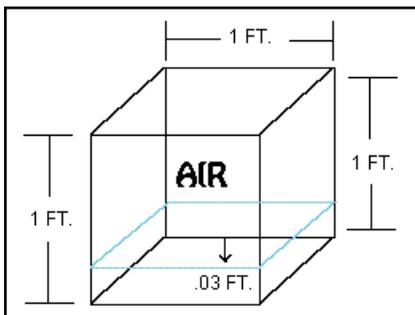
This test measures the amount of air allowed to pass through a window or door system when it is subject to a pressure differential between the interior and exterior surfaces.

This pressure differential simulates the resulting force that is exerted by wind striking an operating fenestration product. For all residential and commercial windows, a 1.57 pound per square foot (psf) differential is used as a standard for testing. This pressure difference is equivalent to the force exerted by a 25 mph wind. In tests involving heavy commercial double hung and horizontal sliding windows, a pressure difference of 6.24 psf is used (this is the force exerted by a 50 mph wind). The results of these tests are commonly stated in this manner: **.03 CFM/FT @ 25mph.**

This statement means that .03 Cubic Feet of air passes through this window system every minute for each measured foot of crack length. By breaking this statement apart, we can better understand the air infiltration test.

Cubic Feet of Air:

A cubic foot of air is the amount of air that would naturally fill a standing box measuring one foot high, one foot wide and one foot deep. In the above example, the amount of air measured is .03 cubic feet. This is 3/100ths of the air that would fill the box (see below).



CFM (Cubic Feet per Minute):

This is the measure of the rate that the air will flow across a particular point. In the above example, 3/100ths of a cubic foot of air flows in the first minute of testing. After two minutes, there would be 6/100ths. After three minutes there would be 9/100ths, and so on.

Per Foot of Crack Length:

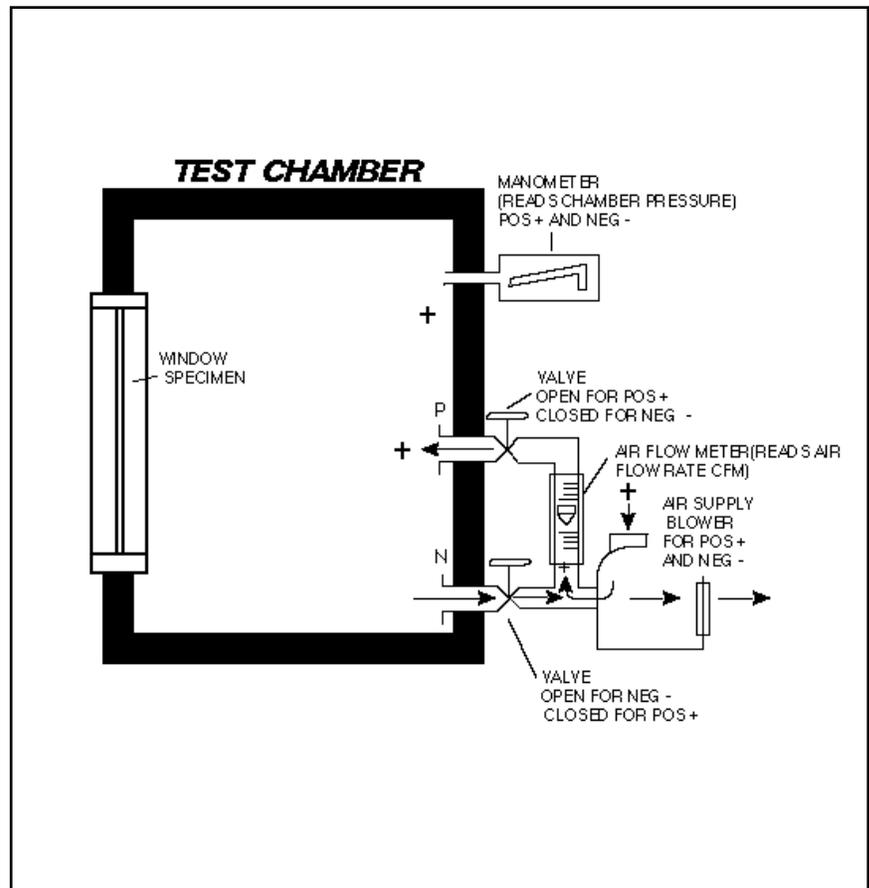
Crack length can be described as the areas through which air is able to flow. In a window system, these areas would include the gap (or crack) between the meeting and locking rails, the crack between the operating sash and the frame, and the crack between an operating sash and mullion.

@25mph:

This is a standard wind speed for which the window system is tested. As a result of this wind, the difference between the air pressure on the inside of the window system compared to the exterior of the wind is 1.57 pounds per square foot.

With these definitions we can clearly understand the published air infiltration numbers.

In our example below we know that for every foot of crack length in this particular window, .03 cubic feet of air will pass from one side of the window to the other every minute when a 25 mph wind is exerted on the surface.

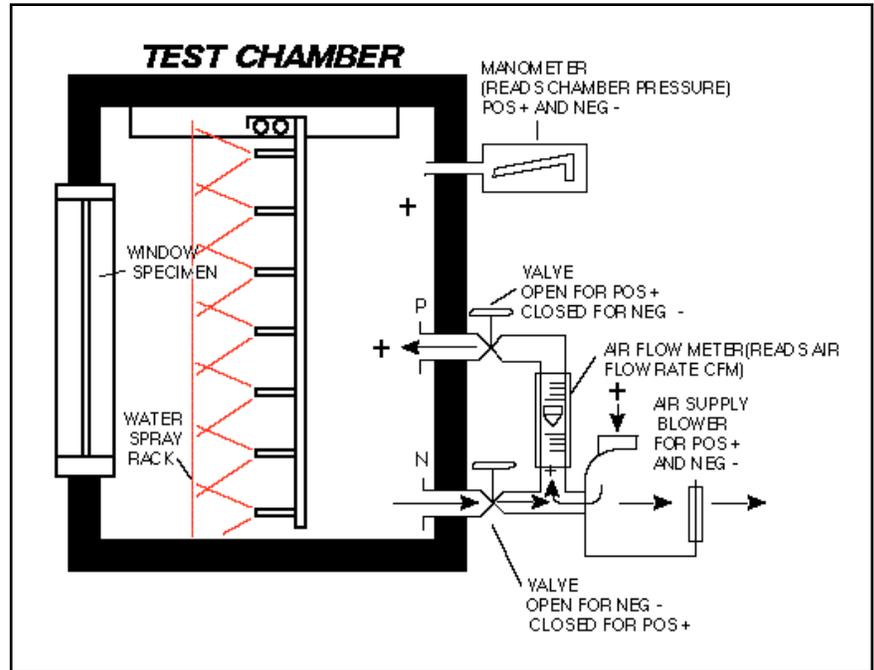




H₂O Resistance Tests

Windows are tested for their ability to prevent water passage from the exterior to the interior of a home.

In a water resistance test, a window system is mounted on one side of a sealed chamber. During the test, a specified pressure is exerted perpendicular to the window surface for five minutes and then removed for one minute while a continuous spray of water is applied. This cycle occurs four times. The water is sprayed at a minimum rate of five gallons per hour per square foot of window area, equivalent to rainfall measuring eight inches per hour. If any water has passed through the window to its innermost plane, the window has failed the test. If no water has penetrated to the innermost plane, the window passes.



(PSF) PRESSURE	MPH
.256	10
1.024	20
2.304	30
4.096	40
6.4	50
9.22	60
12.25	70
16.38	80
20.74	90
25.6	100

A typical water penetration test result will state a number presented in pounds per square foot (PSF). This is the maximum amount of pressure that can be applied to the window without water penetrating to the interior.

To obtain a clear understanding of how this force relates to actual weather conditions, one can refer to the chart on this page showing the force is exerted by specific wind loads.



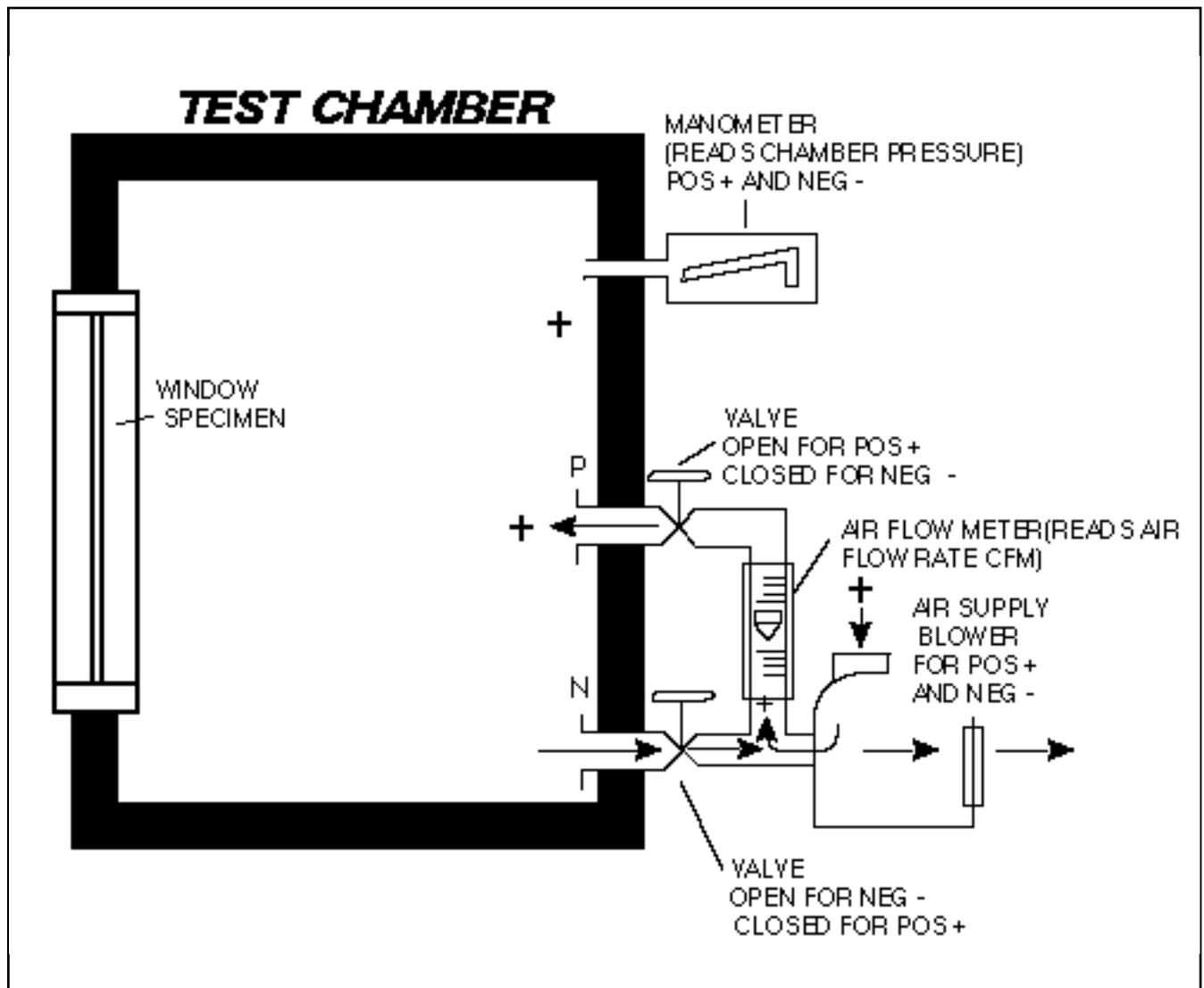
Uniform Load Structural Test

As the name implies, this test will determine the structural strength of a window or door unit. During the test, a force is applied to the sample window system mounted in a closed test chamber similar to the figure shown.

First, the load is applied to the external side, then the internal side for a minimum period of 10 seconds. After the applied pressure, the window will have passed the test if there is no glass breakage and there is no permanent damage to any of the fasteners, hardware parts, support arms or actuating mechanisms.

Also, there must be no other damage which will cause the window to be inoperable and there must be no significant permanent deformation of any main frame, sash or ventilator member. "Significant permanent deformation" is defined as a deflection not in excess of 0.4% of the members span. For example, in a window system measuring 3 feet wide and 5 feet high, the head and sill span a distance of 36". If the head or sill member of this 3'x5' unit were to permanently deform by more than 0.144 inches after testing, the window would fail (36" X .004 = .144").

When a uniform load structural test is listed in a window system test report, the test result is listed as a certain number of pounds per square foot (PSF). This is the maximum amount of force tested that the window could withstand without sustaining the permanent damage described above.





AAMA Classification

The American Architectural Manufacturers Association (AAMA) is a trade association of firms engaged in the manufacturing and sale of architectural building components and related products.

Tracing its origins back over 50 years, AAMA is active in its role as the "Technical Information Center" for the industry's products. These include windows, sliding glass doors, storm windows and doors, curtain walls, store fronts, skylight and space enclosures, siding and other related materials. AAMA has developed many of the Voluntary Specifications for PVC prime windows and doors that are based on testing procedures developed by the ASTM (American Society of Testing and Materials). Based upon a window's specified test results, AAMA assigns an alphanumeric designation that serves to summarize the performance of a particular fenestration product. A typical AAMA classification looks like this:

DH-R35:

The letters preceding the hyphen are used as a product description. In our example, the system with this designation is a hung window (either single, double or triple). Other letter designations will describe other product types including fixed (F),

GRADE DESIGNATIONS

Minimum Designation	Minimum Test Size (Double Hung)	Grade Design Pressure (psf)	Minimum Structural Test Pressure (psf)	Minimum Water Test Pressure (psf)
R	3'8" x 5'0"	15	22.5	2.86
C	4'5" x 7'6"	20	30	3.00
HC	5'6" x 10'0"	40	60	6.00

horizontal sliding (HS) and greenhouse (GH) windows (see "Product Symbol System" chart).

The letter following the hyphen serves to describe the Window Grade. There are three typical grades used in PVC window systems; Residential (R), Commercial (C) and Heavy Commercial (HC). To be classified into one of these categories, the window must be tested at a minimum test size and meet specific minimum requirements in structural and water testing (see "Grade Designation" chart below). As one can discern from the chart, windows with a residential classification are required to meet lower standards than those of commercial or heavy commercial grades.

The number following the grade classification designates the minimum design pressure for which the product will successfully test. The Grade Designation chart clearly shows that minimum design pressures are related to a minimal structural test pressure (the "actual" pressure applied to

the window during the uniform load

structural test procedure) and a minimum water test pressure (the "actual" pressure applied to the window during the water test procedure).

From the example above, one can clearly understand the performance class of a window with this designation. This sample window is a hung window (DH), meets the minimum test requirements for a residential window (R) and successfully passes tests for a minimum design pressure of 35 pounds per square foot (35). There are various methods of classification and performance designations.

For a more detailed description one should refer to AAMA's Window Selection Guide available from the American Architectural Manufacturer's Association (312)699- 7310.

PRODUCT SYMBOL SYSTEM

Product Type		Grade	Performance Class			
Code	Product	Designation/Description	Design Pressure	R	C	HC
A	Awning	R Resident	15	•		
C	Casement	C Commercial	20	•	•	
DH	Double (Single) Hung	HC Heavy Commercial	25	•	•	
VS	Vertical Slide		30	•	•	
F	Fixed		35	•	•	
HS	Horizontal Sliding		40	•	•	•
P	Projected		45	•	•	•
TH	Top Hinged		50	•	•	•
VP	Vertical Pivoted					
GH	Greenhouse					
JA	JAL-Awning					
J	Jalousie					
DA	Dual Action					

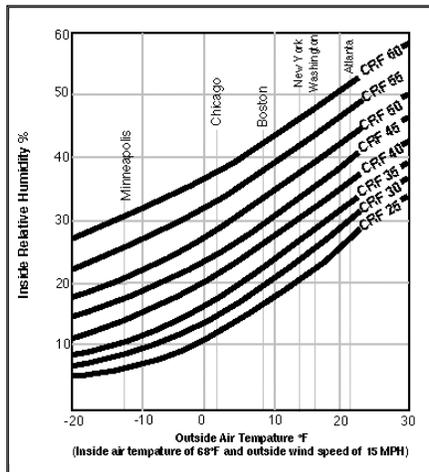


CRF (Condensation Resistance Factor)

In terms of window design and construction, condensation is the formation of water on the interior surfaces of the window system. It occurs when the surface temperature of the window is such that the air immediately surrounding it cannot retain its suspended water vapor. To understand the CRF of a window system, one must understand the cause of condensation.

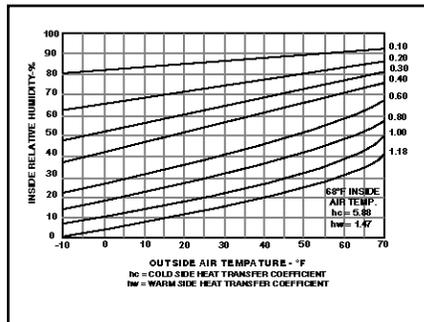
Warm air has the ability to "hold" more water than cold air. This is the reason for those hot, humid days during the summer. When warm moist air (i.e. air with a high relative humidity) is cooled, water will condense out of the atmosphere and collect on surrounding surfaces. Morning dew is a common natural occurrence of condensation. The sun will warm the atmosphere during the day allowing it to collect and hold more moisture. As nighttime occurs and the air cools, the water condenses on the ground.

The same phenomenon occurs in a window system. If the interior surface of a window is sufficiently cold (relative to the interior temperature of the home) and the interior relative humidity of the home is sufficiently high, water will condense on the window surfaces.



Condensation resistance factor curves for thermalized windows, min. CRF = 35.

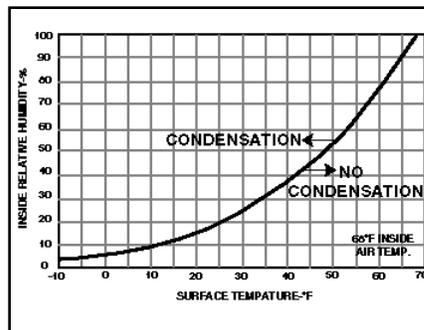
It is then obvious that the thermal efficiency (i.e. the ability of a window to limit the transfer of heat) of a window system is critical to its ability to prevent condensation. That is to say, if the glass and framing material of the window have the ability to prevent the interior surfaces from losing heat, then the window will have the ability to prevent undesirable condensation.



Outside air temperatures at which condensation will occur on inside surface for different U-values and inside relative humidities.

The CRF designation is a whole number that describes the windows ability to prevent condensation formation on the interior surfaces of the unit.

It is directly related to the windows thermal performance. Determining the CRF of a window involves a number of temperature readings across the interior surface of the window at specified points on the glass and framing material while



Relative humidity and surface temperature at which visible condensation will occur.

the window is experiencing a thermal difference between its interior and exterior surfaces (i.e. the temperature outside the window is colder than the temperature inside the window). Using various mathematical formulas along with referenced historical studies, a CRF number can be assigned. In typical thermalized window systems, these numbers can range from 30 to 90. With higher CRF numbers, extreme conditions must exist before condensation will form on the interior surface (i.e. a relatively high interior humidity combined with a relatively low outside temperature). The charts below will help you understand what conditions must exist for water to condense on a particular surface. They will also help you understand the types of climatic conditions where CRF may be an important selling feature.



A COMPARISON OF WINDOW MATERIALS

Wood has a rich history in many different areas of construction. From the ships that first brought settlers to America to the construction of millions of homes throughout the nation, wood has been the premiere building product of modern times. Wood is a readily accepted material for use in the construction of window and door products and gains popularity from its many features. However, trees are becoming scarce throughout the United States and we will not always be able to depend on an unlimited, low-cost supply of wood products. Recent news stories have reported concerns that our forests are rapidly depleting, and endangered species that live in these forests are losing their natural habitat and ability to survive. Even our government is beginning to sell parts of our National Forests to logging companies in an attempt to counteract the dwindling supply of good wood.

There are alternative materials that are available to counteract the destruction of our forests. These products are durable, readily available, and have many added features that wood could never match. Vinyl replacement and new construction window products are one of these products. Through years of development, vinyl has become the smart alternative to wood.

Vinyl is a Natural Insulator with low maintenance . . .

Though wood is a natural insulator and prevents heating or cooling loss through material conduction, it constantly needs to be maintained. Scraping, painting, and staining wood windows year after year in an attempt to ward off the effects of weathering becomes a tedious and expensive chore.

Vinyl windows are also an excellent insulator. They reduce your heating and cooling bills by preventing thermal loss through the frame and sash material. Vinyl windows, however, need little more than a wash of mild detergent and water to keep them looking as new as the day you installed them. Muntins (for divided lite windows) are located within the window. You won't have several different panes of glass to clean, just one smooth surface. Any minor surface scratching caused by weathering won't show because the color goes all the way through the frames and sashes. Vinyl and wood are natural insulators, but vinyl retains its lasting appeal with little or no maintenance.

Atmospheric conditions won't affect vinyl . . .

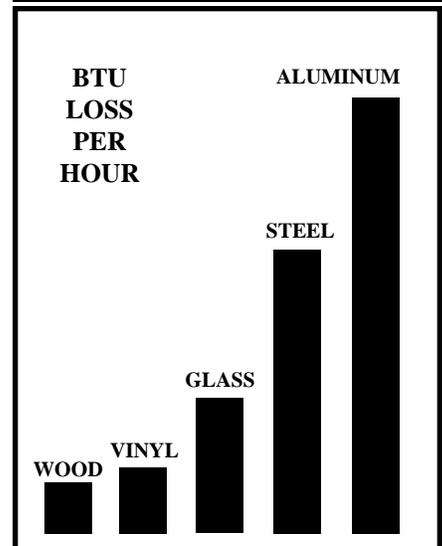
Neglected wood windows are affected by every kind of atmospheric condition including air pollution. A wood window will absorb moisture and begin to swell or warp, making a window hard to operate or impossible to open. The warped and swelled frame members will not meet correctly, leaving large gaps and cracks throughout the frame. Heating or cooling lost through these gaps can increase your energy bills while your home remains drafty and damp. Untreated wood frames and sashes will eventually rot and infestations with insects or chemicals can cause permanent damage.

Vinyl windows are not affected by the weather or air pollution. Salt air, acid rain, industrial pollution, pesticides, lawn fertilizers, smog and other air contaminant's normal to every day living cause no discoloration or structural damage to vinyl windows. They won't rot, chip, flake or peel.

Vinyl Shapes are Intricate and Detailed . . .

If you have ever worked with wood, you know there exists a limit to how thin wood can be cut before it loses its strength. This is crucial to the sophisticated engineering that goes into the design of modern window systems. Wood windows are inhibited by the nature of the material. It is impossible to mill sophisticated weather-stripping pockets and sash interlocks into the frames and sashes. These items are necessary in any window system, for it to properly prevent air and water infiltration through the gaps that naturally occur in a working window. Also, hardware that supports the sashes in their daily operations is difficult to conceal and may become hard to operate after years of wear. As a result, many wood window companies use vinyl and aluminum products where they feel wood lacks the necessary qualities.

Which Window Materials are the Best Insulators?





Vinyl can be extruded to precise thicknesses and still retain superior structural strength. This means that intricate weather-stripping pockets can be designed throughout the system. These pockets are superior to the designs found in wood and provide the window with multiple weather-stripping that will remain in the window throughout its lifetime. Also, interlocks at the meeting rails that prevent air infiltration between the moving sashes can be integrally designed into the profile. This adds strength and durability to the meeting rail while preventing the escape of heating or cooling through this critical space. The same method can be used for the lift rail. Integral in the lower sash, the lift rail will remain strong and true throughout the life of the window. The use of vinyl offers another alternative to the use of nails, staples or screws in the window corners—fully fusion welded windows.

Cut at two complementing angles, the vinyl pieces are slightly softened and melted by heated welding plates. The pieces are pressed together and the material is allowed to cool. The result is a water tight joint that gains its superior strength from the entire cross section of the profile instead of only a few points. Strength tests conducted on these joints have shown that welded window systems have a superior strength over mechanically fastened sashes and frames. Ultimately, these methods provide consumers with longer lasting and more dependable window and door systems.

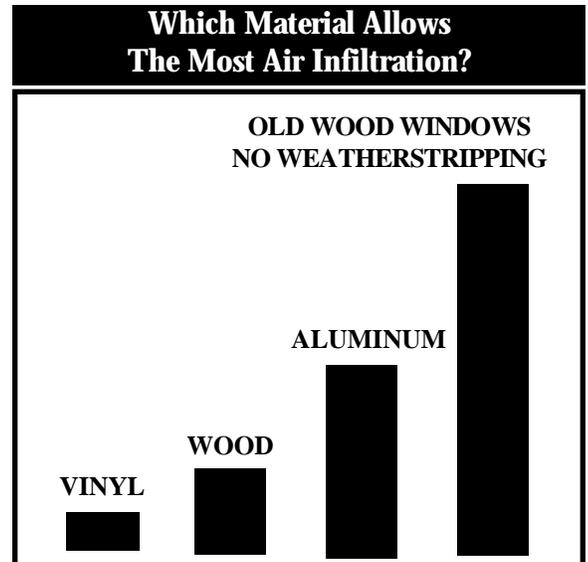
ASK THESE QUESTIONS . . .

Builders, Contractors and Remodelers

Before you purchase wood or aluminum windows, ask the salesmen these simple questions . . .

- Is the window resistant to atmospheric conditions and air pollution?
- Is the color of the window material throughout?
- Is the window multi-chambered in design?
- Does the window have integral interlocks and an integral liftrail?
- Is the window weeped internally?
- Is the material the window is made from warm to the touch and a high thermal insulator?
- Is the window corrosion resistant and impervious to termites?
- Is the window easily fitted directly into the opening?
- Is the window maintenance free?
- Will the window swell, warp, or rot?

If they can't answer "yes" to every question, then VINYL windows should be your choice for new construction or remodeling.





Wood

Advantages

- ✓ Excellent insulator.

Disadvantages

- ✗ Absorbs moisture. This can lead to possible rotting or warping, resulting in air & water infiltration.
- ✗ Needs regular painting, maintenance both inside and out - - paint then chips & peels.
- ✗ Inferior milling qualities.

Aluminum

Advantages

- ✓ Won't rot or Warp

Disadvantages

- ✗ Extremely poor insulator.
- ✗ Allows condensation to form.
- ✗ Pits, corrodes, dents and scratches.
- ✗ Most frames & sashes are mechanically connected (usually with screws), and may eventually loosen.

Vinyl

Advantages

- ✓ Excellent insulator
- ✓ Reduced air infiltration
- ✓ Resists condensation
- ✓ Easy to clean
- ✓ Durability - No pitting, peeling, rotting, drying out, or corroding.
- ✓ Virtually Maintenance free
- ✓ Easy operation
- ✓ Custom size of opening
- ✓ Solid color throughout
- ✓ Never needs painting
- ✓ Integral lift rails, interlocks, and weatherstripping pockets

Disadvantages

- ✗ Limited tensile strength. However, windows may be reinforced with aluminum to compensate.



Aluminum has been a widely accepted material used in window and door frame construction. Initially, it was thought to be a readily inexpensive alternative to wood framed windows and doors, performing with structural integrity while remaining friendly to the environment. Upon closer inspection, however, aluminum possesses many characteristics that make it unacceptable in the construction of modern windows.

In the pretreatment of aluminum, many toxic chemicals are used throughout the process of creating window and door profiles. Chromate baths for rinsing the bare metal prior to priming and painting, acrylic and polyester enamels used to paint the bare aluminum, and nickel acetate used to create protective anodized coatings, have all been labeled toxic or carcinogenic by the Occupational Safety and Health Administration (OSHA). If not closely monitored and controlled, these chemical agents can cause illness and death from prolonged exposure. Studies have shown that aluminum in the environment can affect the growth of beech and spruce trees, as their fine roots are attacked by the many by-products of production.

Alternative materials do exist that can counteract the spread and use of these toxins in our environment. Vinyl, a plastic material made from PVC, is durable, readily available, and has many added features that aluminum could never match. More importantly, the processes used in creating vinyl windows and doors yield only water vapor into the atmosphere. No harmful chemicals or toxins are dumped into our surrounding rivers and streams. Also, any vinyl not used in the manufacturing plants can be recycled into other useful products. Vinyl replacement and new construction window products minimize waste and environmental harm as they provide one of the most efficient building materials used today. Through years of development, vinyl has become the smart alternative to aluminum.

Vinyl is a natural, low cost insulator.

Aluminum is a natural conductor of heat. Metal frying pans transmit the heat of the stove top element throughout the metal surface. Holding the bare metal handle would easily burn someone's hand unless an insulating material was used to separate the hand and frying pan. Similar problems occur in aluminum windows. The heat of summer or the cold from winter will be transmitted directly through the aluminum frames and sashes causing considerable heating or cooling loss to the interior of a home. To counteract this effect, aluminum window companies add a "thermal break" to many of their window and door products. This break is normally a stiff resin strip that is inserted into the body of the frame and sashes. Though it increases the insulating value of the window system, the structural integrity of the aluminum frame is compromised because the thermal break is not as structurally sound as the aluminum it is replacing. Also, this process adds extra cost to the window from added time and labor needed to add this extra material.

Vinyl is a natural insulator. It does not transmit heat easily through conduction. Even when the winter chill surrounds a home, vinyl window and door frames remain warm to the touch. They create a natural thermal barrier for your home without the added cost and detriment of aluminum's "thermal break".

Vinyl windows also utilize multi-chambered profiles in their window designs. These chambers divide the spaces found within the window and door frames and sashes. By dividing the space inside, severe exterior temperatures and comfortable interior temperatures never come in direct contact. Aluminum windows utilize chambered profiles as well, but because of the nature of the material, interior aluminum chambers are surrounded by temperatures transferred through the profile. The actual design feature of the chamber is defeated by the conduction properties of the metal. Vinyl windows have the advantage as the chambered profiles are surrounded by a natural insulating material. This means that vinyl frame and sash

designs are an added feature keeping your home comfortable and lowering your heating and cooling bills.

Atmospheric conditions won't affect vinyl.

Aluminum won't rust, but it will corrode. Even painted aluminum surfaces will nick and scratch from constant external weathering or daily internal operation. Corrosion can cause discoloration of the window surface and eventually window failure. Aluminum also experiences electromechanical effects from many different sources that are found in everyday living. Lawn fertilizers, salt air, and industrial pollution can cause an aluminum window system to become unsightly and undependable. Also, because of its inherent thermal conduction properties, aluminum windows can cause a condensation buildup in the interior of the home. If unchecked, this condensation can run off the window surface causing damage to interior fabrics, wallpaper, and wood surfaces.

Vinyl windows are not affected by the weather or air pollution. Salt air, acid rain, industrial pollution, pesticides, lawn fertilizers, smog and other air contaminants that are normal to everyday living cause no discoloration or structural damage to vinyl windows. Interior condensation is a fraction of what builds up on aluminum windows and usually evaporates before any damage may occur inside your home. Vinyl windows and doors won't rot, chip, peel, or flake. Surface scratches caused from everyday use won't show because the color of the window goes all the way through the profile. Vinyl windows and doors won't warp or fade, so your windows will always operate properly and retain their good looks.



Vinyl is a strong, durable material for windows.

Logically, one would think that an aluminum window would be stronger than a vinyl window because it is made of a tough rigid metal. Actually, the material used in the frames and sashes is of little importance when counteracting the natural forces on the installed system. A window or door will normally fail from the effects of lateral shear forces. These forces created by the wind and the settling effects of the structure, will push against the sides of the window creating severe stress in the corners. Thus, the most important part of window strength comes from the method and materials used in fastening the corners together.

Aluminum windows use mechanical fasteners to connect the different parts of a window or door. Usually three or more sheet metal screws are used to create a structurally sound joint. Even if the screws are stainless steel, they can create a galvanic reaction with the aluminum frames and sashes. This will lead to the degradation of both the screws and the aluminum window system and could eventually cause a failure at the corners. Vinyl, on the other hand, has no reaction even when screws are used to mechanically fasten a window joint. Tests conducted on a mechanically fastened vinyl window have found that vinyl and aluminum joints possess similar structural strength.

Vinyl offers another alternative to the use of screws and fasteners in the window corners—fully fusion welded windows. Cut at two complementing angles, the vinyl pieces are slightly softened and melted by heated welding plates. The pieces are then pressed together, and the material is allowed to cool. The result is a water tight joint that gains its superior strength from the entire cross section of the profile instead of only a few screw points. Strength tests conducted on these joints have shown that welded window systems have a superior strength over mechanically fastened sashes and frames. Ultimately, these methods provide consumers with longer lasting and more dependable window and door systems.

ASK THESE QUESTIONS . . .

Builders, Contractors and Remodelers:

Before you purchase wood or aluminum windows, ask the salesmen these simple questions . . .

- Is the window resistant to atmospheric conditions and air pollution?
- Does the material the window is made from have .08" wall thickness?
- Is the color of the window material throughout?
- Does it tilt in for easy cleaning?
- Is the window multi-chambered in design?
- Is the window corrosion resistant and impervious to termites?
- Are there three weather seals?
- Is the window easily fitted directly into the opening?
- Does the window have integral interlocks and an integral liftrail?
- Is the window maintenance free?
- Is the window weeped internally?
- Will the window swell, warp, or rot?
- Is the material the window is made from warm to the touch and a high thermal insulator?

If they can't answer "yes" to every question, then VINYL windows should be your choice for new construction or remodeling.



Wood

Advantages

- ✓ Excellent insulator.

Disadvantages

- ✗ Absorbs moisture. This can lead to possible rotting or warping, resulting in air & water infiltration.
- ✗ Needs regular painting, maintenance both inside and out - - paint then chips & peels.
- ✗ Inferior milling qualities.

Aluminum

Advantages

- ✓ Won't rot or Warp

Disadvantages

- ✗ Extremely poor insulator.
- ✗ Allows condensation to form.
- ✗ Pits, corrodes, dents and scratches.
- ✗ Most frames & sashes are mechanically connected (usually with screws), and may eventually loosen.
- ✗ Painted Aluminum windows are subject to chipping and scratching.

Vinyl

Advantages

- ✓ Excellent insulator
- ✓ Reduced air infiltration
- ✓ Resists condensation
- ✓ Easy to clean
- ✓ Durability - No pitting, peeling, rotting, drying out, or corroding.
- ✓ Virtually Maintenance free
- ✓ Easy operation
- ✓ Custom size of opening
- ✓ Solid color throughout
- ✓ Never needs painting
- ✓ Integral lift rails, interlocks, and weatherstripping pockets

Disadvantages

- ✗ Limited tensile strength. However, windows may be reinforced with aluminum to compensate.



Quality Vinyl

There is a Difference

All extruded vinyl lineals are not alike. Therefore the windows that are made from these lineals have different properties and varying abilities to withstand the rigors to which most windows are subjected. All windows when first fabricated perform adequately. It is how these window stand up to years of use that separates the good ones from the bad ones. No matter how well they are designed, stress and weathering are the downfall of most window systems.

Stress damage is the result of daily operation of the window. Window failure due to weathering is a result of the contrasting temperature, moisture and UV ranges on the interior and exterior surfaces of the window system.

The lineals are a product of the unique VEKA Process and are better able to handle these stresses and weathering which results in longer lasting, better performing window system for the homeowner.

There are four key elements to the VEKA extruded lineal process that make it superior to other lineals:

Compounding, Blending, Extrusion, and Design.

Compounding

The patented formula of the PVC used in the VEKA process is a result of 20 years of European research and installation experience which has resulted in a computer controlled, dry blended mixture of ingredients that:

1. Imparts superior impact resistance
2. Lowers notch sensitivity
3. Increases color retention, and UV resistance.

In preparing the raw PVC for extrusions, the choice, the quality and the blending of these ingredients are of equal importance.

The PVC - Only pure Virgin Vinyl is used by VEKA INC. Less expensive, recycled vinyl imparts impurities to the lineal, creating weak points and warpage.

Impact Resistance - Expensive Impact Modifiers are used in limited amounts in other extrusions. Most vinyl compounds tend to fracture at low temperatures. Not VEKA INC. In the VEKA formula, the impact modifiers are used in sufficient quantities to enable the lineal to withstand a one kilogram weight, dropped from one meter height, at minus 20 degrees Celsius, without damage.

Color Retention and UV Resistance - Simply put, the ingredients (Color Stabilizers) used in the VEKA formula keep the finished window from fading or becoming brittle - year after year.

There are other ingredients in the VEKA formula that help the raw vinyl compound become a superior lineal. Though some may be used in other vinyls, it is important to note that other manufacturers have designed their formulas to obtain the least expensive structural vinyl while VEKA has designed their formula to obtain the best.

Blending

Any mixture, that combines ingredients to become a compound, is better and longer lasting the more homogenous it is. Raw compounds, when blended by others or in haphazard way, can be compromised to save time, labor, and money. VEKA developed their own formula. It is computer combined and blended at the point of extrusion into a homogenous compound. The process is unique in the world, and the result is patented because the VEKA compound offers both exceptional uniformity and exceptional consistency.

Uniformity - A finer mixture is a more uniform mixture distributing the ingredients evenly throughout the lineal. This improves "notch resistance" to the level above other lineals. "Notch Resistance" is the tendency of a lineal to become weak at the point where a slot or cavity has been

cut into the frame member, particularly at a joint or where hardware will be attached.

Once "notched" most lineals become very weak. They tend to "tear" easily. The computerized blending of the VEKA compound distributes the impact modifiers so finely and evenly that the weakening of the lineal is minimized to a point well below other vinyl lineals.

Consistency - Computer blending and mixing delivers a more consistent vinyl, lineal after lineal. The frame members have to act in concert as a total window unit. No deviation in strength, flexibility, or density can be tolerated or the window will work against itself and failure can occur. In addition, if shape, size, and color vary, the finished product will not take on and maintain its quality appearance.

Extruding

A properly formulated and blended PVC mixture isn't enough. It must be formed into a window piece with exacting precision. But even more than that, the ingredients blended into the vinyl can be compromised by the stress of the extruding process. This is often done by other extruders who rush the process to save a little time and money.

PVC, like all materials, expands and contracts due to temperature changes, and can change shape under stress. The result can be permanent "deformity" or a temporary "flex". It depends on the ability of the PVC to return to its original shape time after time. The key to PVC returning to its original shape - is its "memory".

All plastic has a memory. It "remembers" its shape and size when it was under the most stress and tension. If tension and stress is "built-in" during extrusion, after the first few times the lineal in a window is expanded or contracted due to environmental temperature changes or flexation, it will "remember" (and return to) a different shape and size.



This results in a "distorted" window that closes poorly or won't lock. To avoid this common problem, during extrusion the lineal must be shaped in such a way that the size and shape at the end of the extrusion is the one it "remembers" during use in the home. This takes place during the extrusion and cooling process. In order to save time and money, most extruders try to strike a balance between the built-in stress, and the memory of the lineal. In the VEKA process, there is no compromise.

Extrusion - Softened by heat, the vinyl compound is "pushed" through a die, and "pulled" through the cooling process when extruded. If the pull doesn't equal the push, the lineal is alternately compressed and stretched which stresses the lineal. Even if these stresses are minute, they will be part of the "memory" of the lineal. It will cause changes in the shape and length of the lineal in the window unit during heat and flex expansion, and will not allow the window pieces to expand and contract in unison. When they cool, they return to a different shape and length.

The VEKA process is computerized to exactly match the "pull and the push". This eliminates the wrack and torque forces literally extruded into other lineals.

Cooling - It is during the cooling process that vinyl is "frozen" into its shape. Like tempering, the quicker the cool, the more tensile stress is imparted. Some extruders find this process puts back some of the rigidity lost when too little impact modifier additive is used. But reheating from the sun can mis-shape a highly tensile material. Just as tempering can make a material brittle, vinyl more easily shatters if it is cooled too quickly.

The VEKA process uses up to seven (7) calibrators to cool the vinyl slowly and evenly. Very little stress from cooling is imported to the lineal. It is these calibrators that maintain the consistent shape and unique smoothness of the lineals used in each vinyl window. Each calibrator contains a "negative" die and a vacuum. This

reverse of the extrusion die, coupled with the vacuum, continually modifies and refines the shaping of the lineal. In effect, the lineal is shaped and cooled at the same time. It has virtually no internal stress, and the shape it possesses when it leaves the last calibrator is the shape it remembers during the life of the window.

Design

Heavy walled, multi-chambered design improves thermal performance, increases condensation resistance, reduces sound transmission, and increases strength.

Thermal Performance - Properties of vinyl make it ideal material to reduce heat transfer because of its low "U" value. The chambers in the frame pieces further reduce the transfer of heat by creating air-isolating insulation cells. Increasing air space over 3/4" does not increase insulation value. However, taking the space and creating multiple and isolated air spaces does increase insulation value, much like layering clothes in the winter.

Condensation Resistance - Multi-air-isolating chambers also reduce the tendency of the frame members to condense water vapor. This annoying condensation happens most often in the winter on the inside surfaces of the window frame because of temperature differences between the outside and the inside is transferred through the frame. It can even happen in vinyl frames that do not have multi-air-condensation, and convection currents in the chambers, cause most of the condensation to occur in the outer cell where the drainage slots are.

Though most quality vinyl windows have cells, the VEKA window has up to 8 cells in critical places. But perhaps more important, the quality of the extrusion, and the memory of the vinyl built-in VEKA keep these cells isolated at the joints, and where hardware is attached.

Warped, or mis-aligned webs cannot line-up at the joint, allowing the air in one cell

to spill into another. This effectively links all cells into one, and eliminates the advantage of isolated cells, thereby reducing insulation value and encouraging condensation nearer the interior surface of the window.

Sound Transmission - Multi-cell design and rigidity keep noise transmission down below levels transmitted by competitive windows. The isolating air cells and the stiffness of the frame members reduce transmitted and conducted sound. Sound levels are reduced up to 40 decibels in most VEKA windows.

Strength - Deflection in sash and frame members are the result of inadequate internal stiffness. These deflections, in extreme, can cause de-glazing, poor fitting interlocks, and poorly operating sash. Stresses built-up during installation can deflect the jambs which can then bind the sash, or worse, cause the tilt locks to not engage properly.

The extra wall thickness, and the quality of the extrusion process create a double benefit in strength:

1. The walls are stronger and more rigid, and
2. The internal webs are straighter and stronger.

When the walls and webs are straighter and stronger, they resist flex which can weaken the structural strength of the wall and internal supports. Because the walls and webs are straighter and stronger, the hardware mounts more tightly. The snap-in glazing bead is tighter when installed, and easier to remove for re-glazing. Flat walls and straight webs weld together at a corner. This creates extra-strength and maintains isolated drainage chambers with no moisture penetration into the central reinforcement chamber, thus avoiding the corrosion of steel reinforcements.



Better Materials do make a Better Window

These are just some of the features and benefits of the precision quality control and superior design of the VEKA lineal used in the vinyl windows.

All windows work well when they are first installed. It is the environment into which they are installed that wears them down and causes them to fail. That is why most homeowners are faced with eventually replacing their old windows. But, to replace old windows with new windows that also won't last is both foolish and expensive.

This is the advantage of VEKA window systems. They are built to perform and are built to last. They withstand the environment of the home and the extremes of temperature, moisture, wind, and use. They withstand installation and also the rigors of time.

For most homeowners, the first replacement window they will buy will be vinyl. If it's a VEKA window, it will be their last.

Quality is Partnership

A VEKA window works only as well as it is specified and installed by your dealer. Only his experience, dedication, and craftsmanship can deliver the promise built in to every VEKA window.

Quality Service

Marketing

Veka's marketing department has developed an innovative and cost efficient way to market your company. By utilizing progressive ideas and up the minute marketing strategies, Veka offers a highly comprehensive program to support you with your marketing needs. Customized to fit your individual preferences, this program was designed to maximize your marketing options without cutting into your budget. Veka marketing offers you the features and benefits of desktop publishing, video production, 3D modeling and simulation, computer presentations, market research, and the video wall unit that will be sure to generate interest with existing and potential clients. This intricate system of support offered to you by Veka will not only supply you with numerous contemporary ideas, but also greatly minimize the high costs of outside marketing assistance.

Desktop Publishing

This encompasses a wide array of desktop publishing capabilities that allows us to customize your brochures, flyers, door hangers, and virtually any other forms of printed material. Our 3M color proofing system and flatbed scanner make customizing and changes to your literature quickly and efficiently with detailed accuracy.

Customized Literature

Choose from numerous, full color brochures that feature your Veka vinyl patio door and window systems. These brochures come complete with a professional layout, text, and full-color photos.

Proprietary Literature

If you choose to become more involved

with the conception and production of your brochures, Veka's support team will work with you to achieve exactly what you have in mind. You can offer input on custom layout designs, photographs, and even the written text. Our extensive photo library will aid in finding that perfect photograph. The result is exceptional advertising literature that is exclusively yours.

Video Production

Video has become a timeless medium that crosses all boundaries of our personal and professional lives. Veka utilizes this medium's mass appeal to effectively support and market your company. Choose from our extensive library of support videos, including a sales training series, or create your own exclusive video according to your company's needs.

Customized Videos

Make any one of Veka's videos your own by inserting your company's name and logo. Our marketing department has an all encompassing assortment to choose from. Pick from video selections such as product information and installation instruction.

Proprietary Videos

Untap your video possibilities by letting us help you create your own video. Offer your ideas on topics such as corporate video or video advertisement. The possibilities are only limited by your imagination.

Computer Display Support

Veka's marketing department offers a wide array of computer graphic support options. For large meetings or conferences, Veka can create computer slide shows displayed directly from a personal computer through a video display unit. These shows utilize the latest graphic and animation software packages as they replace traditional overhead and slide materials. For a personal touch, this information can be distributed on floppy discs for play back on your client's personal computers. Corporate



overviews, product descriptions, technical information and training support can be designed to interact with your clients as they experience the latest in presentation support.

3D Modeling and Simulation

Always moving forward, Veka remains on the cutting edge of technology with our three dimensional modeling and simulation system. By using direct input of Auto-Cad files, Veka is able to accurately preview a window system before the actual production process begins. The end result is a clear and exact depiction of how the product will appear once completed. The 3D modeling may be used in promotional literature as photographs, customized or proprietary videos and even a computer generated slide show

Video Production

To gain insight into your market, isolate your customer's needs and optimize your advertising dollar. Veka's marketing department can supply you with the latest research statistics on the vinyl window and door industry. Facts and figures unique to your area can be achieved through local market surveys. Veka is here to help with coordinated research projects that can provide you with the added edge in the tight marketplace of the 90's.

Customer Service

Outstanding customer service is another extension of Veka's all-inclusive support program. Our customer service department is dedicated to maintaining an open line of communication between Veka and our fabricators.

Engineering Changes & New Product Releases

Addressing our customer's questions and concerns are important to us. No matter how minor or major, our customer service department will handle your questions completely and efficiently to your satisfaction. Each customer inquiry and request for information and/or assistance is documented for follow-up assurance. A question or concern from our customers is our cue for an exhaustive search for answers.

Technical Information

Veka wants to ensure that our fabricators are kept up-to-date and well informed about our latest changes and industry standards. Customer service notifies all applicable fabricators about the most recent engineering modifications and new product releases.

Material Return Authorizations

Specific technical information about Veka vinyl windows is at your fingertips through the technical and fabrication manuals that are compiled and distributed by the customer service department. Other technical information such as drawings, test reports, bill of materials, etc. may also be obtained through customer service.

Material return is quick and convenient with the help of Veka customer assistance. After a return request is initiated, it is assigned a Material Return Authorization (MRA) number to be logged with the

grounds for return. Customer Service will also coordinate inter-departmental and customer communication regarding the return, verify the amount of credit due, and prepare the MRA for processing by the Veka Accounting Department.

Customer Price Lists

Detailed price information is provided to our fabricators through the Customer Service Department. We will also prioritize requests and ensure that they get delivered to you quickly.

Plant Tours and Meetings

If a scheduled meeting is requested, our customer service department will skillfully handle all the details. They will organize a plant tour, schedule meeting rooms, and coordinate dates and times. If required, they may even arrange catering and make travel and accommodation arrangements for guests. Veka is willing to help out with any fine details that will make your meeting most successful.

Sales Leads

Based on information acquired through Veka's advertising and promotions, detailed sales leads may be provided to our customers based on their products and territories.



Shipping & Handling

Veka is constantly striving to fully satisfy the needs and expectations of our customers. Convenient and safe profile transportation, maximizing your warehouse space, and convenient pick-up times are important details that our shipping and handling department has worked out for you.

Exclusive Rack System

Veka has developed a unique rack system that is far more beneficial than conventional rack systems. Our profile racks stack easily, saving you valuable warehouse space. Our rack system also enables easy transport on and off the loading docks. This design also acts as a safeguard to protect the profiles and greatly reduces the risk of damage.

Shipping Flexibility

Veka is always available when you need us. Our extrusion plant runs 24 hours a day, therefore we offer flexibility and convenience in scheduling your valuable time of loading and working. Our Shipping and Handling Department can offer you loading methods that can best meet your needs when it is appropriate for you.

Veka Profiles

Veka is constantly considering new and improved means to save our customers time and money. Our non-conventional profile length is the perfect example. Veka profiles are 21 feet in length as compared to the traditional 14 feet. It takes three 14 ft. profiles to equal two of ours. As a result, there is less labor and handling at the profiles' destination, saving you time in loading and unloading. The less handling required, the less risk of profile damage. Fifty-three foot trailers are available for shipping Veka profiles. This will easily accommodate two rows of 21 ft. profiles, with additional room for empty scrap containers for use in Veka's recycling program. When returned with empty racks, a fifty-

three foot trailer will hold as many as 16 containers of scrap material.

Loading Docks

Veka has made loading your profile bundles easier by using shrink-wrap. Shrink-wrapped bundles are protected, easier to inspect and count. These bundles are simply strapped together to decrease shifting and the likelihood of damage.

Technical Support

Veka's technical support system encompasses numerous elements to allow our fabricators to fully utilize the maximum potential of our window and door systems. Technical support includes design support, engineering, testing, training, calculations, etc.

Design

Veka's knowledgeable staff of design engineers are constantly designing window systems that exceed the expectations of the most discriminating evaluations. Working with our technical support team will produce a system design that meets your individual needs and requirements. Our in-house die making capability allows for quick modifications and custom dies.

Engineering Support

Veka fabricators have the convenience of consulting our technical manuals to answer questions concerning a bill of materials list, supplier's list, and fabrication details such as assembly, hardware, or auxiliary profiles, etc. The manuals also include other important details such as VEKA test results including size limitations, installation instructions, quality control guidelines, and sawing instructions. A computer aided drafting and design (CADD) system is fully utilized by VEKA's engineering team. This system lends itself to an accurate and unambiguous depiction of a vinyl lineal before the die is cut.

Manufacturing

Veka's technical support team wants to ensure that our fabricator's manufacturing plant runs with all the ease and efficiency of a well-oiled machine. Veka's Applications Engineers can suggest the most efficient and successful means to maximize manufacturing productivity in all phases of plant layout from reworking, modifying and adjusting your floor plan, sign off, and the set-up of equipment and tooling.

Testing

Veka's Testing Engineers put our windows through rigorous and exacting tests to ensure a quality system is achieved time and time again. Window testing is done according to nationally established standards such as ASTM, AAMA, and CSA440. Both structural and thermal testing are applied to evaluate the high quality of Veka lineals. Structural evaluation includes air infiltration, water penetration, structural performance, inertia moments, and systems limitations while thermal testing is implemented to determine factors such as the U-value, R-value, and condensation resistance factors (CRF).

Training

At Veka, we realize that proper training facilitates a quality end-product. Training is offered at our Fombell, PA plant or at your location, whichever is most convenient.

At your request, a technical audit can be conducted to monitor your progress, answer any questions, or address any problems you may encounter.



Quality Control

At Veka, we understand the need for quality vinyl extrusions and optimum product performance. Veka fabricators can be confident that these features are what drives our Quality Control Department to enforce strict product screening methods.

Test Methods

Statistical Process Control Methods and a Quality Assurance Program are strictly followed to ensure consistent and desirable results. Our systematic in-house program requires careful raw material evaluation and vendor selection to aid in establishing and maintaining high material standards and specifications.

Following the inspection of raw materials, the compound blending process is monitored and then tested to assure a constant high quality vinyl extrusion. The extrusion manufacturing process is closely observed to prevent and correct any minor extrusion problems that may occur. When the product is in the extruded lineal form, profile testing is employed to maintain a consistent level of quality. Our customer's evaluation of the product is the final and most important test. Using input from the fabricator and our quality control staff, the whole process is constantly evaluated and improved.

Competition Evaluation

Our Quality Control Department will perform competitive, quality testing on the competition's profiles to evaluate physical performance such as thermal stability, color evaluation, shrinkage, impact resistance, weatherability, and dimensional analysis.

Equipment Evaluation

Maximum equipment efficiency is imperative to an overall high caliber product. Quality Control can conduct corner weld strength tests to derive the optimum weld parameters for your equipment (i.e. time, temperature, and pressure).

Tours and Seminar

Veka can help you fine-tune the processes taken to develop a superior end product through direct experience. Plant tours are provided for you and your customers at the Veka facility to educate on materials, compounding operations, extrusion, tool and die systems, and product testing.

At your request, Veka will provide a seminar at our Fombell, PA plant for implementing a quality control program at your facility or on the application and use of Statistical Process Control methods.



This question has been posed on occasion with respects to specific economic issues such as contracts and bidding, and also regarding manufacturing capabilities such as technology, materials, window systems and numerous other areas important to our existing Fabricators. It is also the most important question in the decision making process for potentially new customers.

□

This document will answer the question, "Why Veka?" and hopefully provide you with a sense of not only who Veka is, but instill in you a confidence in their products and capabilities. If the differences between Veka and other extruders were few in number, this would be a relatively short task, but because the opposite is true more detail is demanded. The following information will hopefully provide you with the answers to the question.

□

Veka Inc. is the largest manufacturer of vinyl Fenestration products in the world. With plants in Germany, England, France, Belgium and the United States, it is truly an international company whose purpose is to supply those countries and others with the highest quality vinyl window and door systems available in the industry. Because of this diverse involvement and the requirements by architects around the world, Veka's knowledge of window systems and window performance are unexceeded. This knowledge in turn provides it's fabricators with products that excel beyond the competition in terms of Veka's manufacturing capabilities, materials, design, and product performance. It is with these four criteria that we will answer the question "Why Veka?"

□

Veka's manufacturing capability was recognized in 1987 by Plastics Technology magazine by being presented with the CIM award (computer integrated manufacturing) for the extrusion industry. Only four awards are presented each year within the total plastics industry to those companies recognized for having achieved manufacturing excellence through computer integration of their manufacturing process. This "State-of-the-Art" achievement award was the result of Veka's desire to capitalize on the existing Compounding and Extrusion technology available to the industry. Doing so required that it integrate as much of the total "process" into its facility. This process included formulation and control of compounding, computer aided design (CAD) of its window systems, computer aided manufacturing (CAM) of its die and calibration tooling, computerized control of its extruders, and the design and production of much of its own downstream extrusion equipment.

□

The role of the production operator was changed as a result of the computerized process. The concept behind CIM was to address each step within a process, establish its variables, and identify the equipment and the controls necessary to optimize performance. Reducing process variation has radically changed the role of the operator. It extended his area of responsibility from one machine or operation, to three to four lines in the case of extrusion, and to a total facility in the case of compounding. His functional role, as a result, shifted primarily from reacting to machine error or product variation, to monitoring and controlling systems.

□

The successful integration of product development is the transformation from R&D to implementation. This was achieved through the utilization of Computer Aided Design (CAD) systems and Computer Aided Manufacturing (CAM) equipment. Using computers for

Veka Inc. is the largest manufacturer of vinyl fenestration products in the world.

the design and development of window systems and process equipment enables Veka to optimize product performance. CAD systems develop the initial profile drawings of window systems and process equipment, such as extrusion dies, sizers and calibration tables from concept to reality. The CIM system enables CAD design drawings to be programmed and downloaded to computer operated Milling and Wire EDM machines for fabrication (CAM). The net result is the in-house capability to not only design and produce window systems, but to do so on equipment and tooling make by Veka which exceeds that currently available in today's market.

□

This capability helped achieve the design and production of multiple head dies which extrude two and four profiles from a single die. Veka's extrusion dies systems are unique in the industry. The design of profile dies is directly related to the rheology of the compound formulation. Rheology can be defined as the melt and flow characteristics of a polymer as it changes state. This change in state initiates with the dry compound being introduced into the extruder where thermal heats and frictional shear from the twin screws cause the material



to plasticize. The physical changes the material goes through are functions of the stabilizer, process aids and waxes. The resulting melt viscosity creates a pressure within the die as a result of three shear forces - velocity, stress and rate. These three combine to produce various flow rates per unit width of channel. Because the die is made up of

metal surface which in turn acts as a heat transfer cooling the vinyl as it is pulled through the calibrators. Vacuum slots cut along the surfaces of the calibrator create a suction which holds the vinyl against the calibrator cavity. This combination of the chilled water and vacuum transforms the profile to its finished dimensional shape.

The capability to produce our own extrusion die systems, down stream equipment and installation of a water treatment facility were all viewed as prerequisites to optimize product quality...

numerous channels, the die geometry must be designed to conform to the melt and flow characteristics of the PVC extrudate. The velocities of the material moving through the die cavities must be balanced from the centerline of the mass flow to the die wall. If this is not done the pressure distribution of the flow as the material exits the die will produce variations in die swell (thickness and width of walls) and will adversely effect the draw down and rate of the material prior to calibration.

As the vinyl exits from the face of the die it must be cooled into its finished rigid form. This is accomplished through a system of sizers or "calibrators" which are generally six to eight in number. Each calibrator is typically 14" - 18" in length and consists of a cavity cut to the exterior shape of the profile. Each calibrator is made of several sections which are fitted around the hot profile as it exits the die body. The sections are pinned together to completely encompass the profile. Chilled water circulates within the sections to cool the

The number of calibrators, water temperature and line rate influences dimensional stability, shrinkage and form of the profile extrusion. The majority of extrusion companies use only one to two calibrators compared to Veka which uses 6-8. This is significant from the fact that vinyl is an elastomer thereby having some degree of elasticity. If the profile is not cooled below its glass transition temperature (i.e. the point where it will not expand or contract) after exiting the calibrators, it will produce dimensional variation, excessive shrinkage and linear bow. Using 6-8 calibrators assures complete cooling and dimensional stability. By providing a constant water temperature throughout the year, the rate at which the profile is cooled is not compromised during warm weather months. This is accomplished through a series of seven interconnected water reservoirs handling 330,000 gallons of water whose temperature is computer monitored and controlled by cooling towers and chillers. This system maintains water temperature at $\pm 5^{\circ}$ F throughout the year.

The capability to produce our own extrusion die systems, down stream equipment and installation of a water treatment facility were all viewed as prerequisites to optimizing product quality - features that the majority of extrusion companies either lack or obtain to a lesser degree from outside sources.

Veka is the only extrusion company, exclusive of those also producing vinyl siding, that has its own compounding facility. It further distinguishes itself in this area as being the most technically advanced facility was built to support the operation of our profile extrusion needs targeted for 100 extruders. its design objectives were three fold - to provide a system with a high degree of scaling accuracy, consistency and efficiency. The option of purchasing compound was ruled out because of the inability to control and assure the quality of the materials and finished compound. The result was a facility which is entirely computer operated with two people as compared to a manual one run with 8-11 people.

This facility is supported by a testing laboratory with two degree Chemists. All R&D is conducted in house along with testing of materials and finished compounds. Each shipment of raw material is tested prior to being utilized by the compounding facility to assure quality and optimize performance. Compounds produced from these materials are then samples from production and quality control tested. Veka's formulations contain 12-14 ingredients compared to a typical 8-9 additives found in other compounds. The result is improved weatherability, physical performance and thermal stability. In an independent study conducted by AAMA utilizing Associated Laboratories to measure impact and shrinkage from 21 extrusion companies, Veka profiles were placed in the upper 25% performance range in both test categories.



Veka's Quality Control program is designed around total statistical process control - starting with in-house formulation development, to testing of incoming materials, control charting of Blending parameters, testing of finished compounds, control charting of

Veka's Quality Control program is designed around total statistical process control... to chart tests and operating parameters of critical manufacturing processes...

Extruder variables, and finished profile testing. This program is managed by two quality control labs staffed by nine individuals five of which possess B.S. degrees in either science or engineering fields. Each area of operation is monitored through Statistical Process Control (SPC). Control Charts are established on-line and within the labs to chart tests and operating parameters of critical manufacturing processes. We have a similar program we offer our Fabricators which was developed to institute Q.C. procedures and train their employees in the use of process control and statistical methods.

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We hope this total product integration approach which Veka has developed in the design and manufacture of its products sufficiently answers the question "Why Veka?".

PVC Product Development

Vinyl windows and doors are made from a blend of PolyVinyl Chloride resin (PVC) formulated with a select blend of additives to - 1.) create the desired processing conditions for extrusion, 2.) achieve the physical and mechanical properties necessary to assure fabrication of the lineals, 3.) and impart long term weatherability to the finished product. PVC is initiated from base stocks of ethylene and chlorine to produce VCM (vinyl chloride monomer). Vinyl chloride, which is a gas at room temperature, is polymerized from a liquid state. The polymerization process takes place in large pressurized vessels with water serving as the medium to which the liquid monomer is added to form a solution. The solution is maintained in a continuous state of agitation along with the addition of suspension agents and catalysts to regulate the process. An exothermic reaction occurs between 40 to 70° C with the water further serving as a heat transfer. The liquid monomer precipitates as fine particles to form agglomerates of the vinyl chloride polymer (PVC). The PVC particles are then separated from the water slurry by centrifuge and dried in either rotary or fluidized bed dryers.

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PVC resin must be formulated with "microingredients" to achieve a melt rheology that will permit the extrusion of the lineal. This is a result of the inherently low thermal stability of PVC. These ingredients generally comprise 15%-18% of the formula and consist of thermal stabilizers, processing aids, impact modifiers, light stabilizers, lubricants, fillers, and pigments.

Stabilizers: Are added to prevent thermal degradation of the PVC during the extrusion process and extend weatherability of the product in outdoor applications.

Processing Aids: Influence the melt morphology of the compound as it plasticizes. They provide for a homogenous melt and increase the melt strength of the material during the fusion process.

Impact Modifiers: Improve the impact properties of the extrusion by reducing the brittleness and creating a more ductile and highly impact resistant end product.

Lubricants: Are divided into two classes - external and internal. External lubricants create a lubricating barrier between the melt and the metal surfaces within the extruder and dies. They act to reduce sticking and allow for metal release during processing. Internal lubricants create a lubricity within the compound itself to influence the melt viscosity of the extrudate. Combinations of the two greatly influence the flow of the material through the extrusion process.

Fillers: Generally consist of calcium carbonate of a fine particle size. They can influence several properties depending upon usage levels - increase impact strength, reduce elasticity and shrinkage, and lower material costs.

Pigments: Are used to impart color to the product and, as is the case with titanium dioxide (TiO₂), promote long term weatherability by blocking UV light.

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The compounding or blending of the formula ingredients takes place in high intensity shear mixers. The PVC along with the microingredients are pre-weighed and charged first into a vertical Heat Mixer. The batch size can range from 500 to 1200 lbs. depending on the



capacity of the vessel. During this process the materials are mixed from the shearing action of rotary blades within the mixer. The materials are dispersed into a homogeneous mixture both mechanically and by melting and absorbing onto the surface of the PVC particle. The temperature of the mixture increases due to friction generated from the shearing action of the mixer blades, and from the particles impacting against one another and off the vessel wall. The heat cycle is completed once the material temperature reaches a temperature of 210°-250° F. At this point the batch is transferred to a horizontal Cool Mixer where the material temperature is cooled down to 80°-110° F. The cooling of the material is achieved within a paddle type mixer which is encircled by a water jacket serving to cool the inner wall of the vessel. During this process the hot material continues to mix at lower RPMs and in doing so is cooled down as the compound comes in contact with the chilled wall of the vessel. The water circulating behind the interior wall of the vessel acts as a heat transfer between the material and the vessel wall. The cooling process is completed and the compound is transferred to silos.

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The Extrusion Process converts the dry powder compound to the desired end product by first transforming the material to a plasticized state, and then cooling and forming the material to its finished

The cavities of the die develop into an increasing array of complex channels which divert the material flow into the final profile shape.

profile shape. In the first step of the process the compound is fed into the

throat of the extruder where twin counter rotating screws with intermeshing flights meter the material through the barrel of the extruder. The screws are configured into 4 sections- feed, transition, compression and metering. The geometry of the screw flights differ across each section and impose varying degrees of frictional shear into the material. Thermal heats generated along the 4 corresponding zones of the barrel (340°-390° F) plus with the shearing action of the screws convert the dry powder to a state of flux.

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The plasticized material is then metered into the die body attached to the end of the extruder. The material is channeled through the first plate of the die which represents an embryo of the finished profile. The cavities of the die develop into an increasing array of complex channels which divert the material flow into the final profile shape.

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As the vinyl exits from the face of the die it must be cooled into its finished rigid form. This is accomplished through a system of "calibrators" which are generally 6-8 in number. Each calibrator is typically 14"-18" in length and consists of a cavity cut to the exterior shape of the profile. Each calibrator is made of several sections which are fitted around the hot profile as it exits the die body. The sections are pinned together to completely encompass the shape. Chilled water circulates within the sections to cool the metal surface which in turn acts as a heat transfer cooling the vinyl as it is pulled through the calibrators. Vacuum slots, cut along the surfaces of the calibrator create a suction which pulls the vinyl against the calibrator cavity. This combination of the chilled water and vacuum transforms the profile to its finished dimensional shape.

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Is Vinyl Safe?

Protecting the Family

Many people have questioned the safety of vinyl windows. In an unfortunate situation where a fire occurred in a home, just how would vinyl windows affect the amount of time needed for proper evacuation of the living areas?

There are many national and local building codes that require windows to be of a certain minimum size. This minimum size is the area of opening required for fire fighters to safely enter a dwelling with a life support system mounted on their backs. These codes cover all types of window systems (wood, aluminum, steel, and vinyl) and are all understood by builders, contractors, and remodelers. These codes were designed for the safety of homeowners and their property in the unlikely event of a fire or mishap.

Many studies have been conducted that evaluate the amount of harmful gases released from the combustion of various materials used in the construction of a home and in the manufacture of furniture, curtains, rugs, etc. Most agree that limiting the amount of gases and by-products released from the combustion of these products is the main factor that will ensure a safe and timely evacuation from a burning area.

A test performed at the University of San Francisco evaluated many of the products used in a typical American home. Various materials were tested and the results were stated in the amount of time the material burned to cause incapacitation and death to the occupants in an enclosed area. Surprisingly, cellulosic materials (wood and cotton) performed very poorly while wool and silk were found to be the most toxic material tested. On the other hand, PVC performed quite well. PVC allowed almost 10 percent more time to evacuate a dwelling than wood and twice as much time as silk, cotton, and polyester. These results show that the acceptance of wood

and fabric used in the construction and decoration of American homes, reflects the fact that vinyl is a readily accepted and safe material for use in the construction of fenestration (window and door) products.

The Vinyl Advantage

Protecting the Environment

Preserving the environment is one of the leading concerns we, as a society, face today. Individuals and corporations alike must act responsibly and understand how the products they purchase and manufacture will affect the environment today and tomorrow.

A number of factors can influence how "environmentally friendly" a product or industry is viewed. Those products and industries associated with recycling, energy efficiency and minimal waste disposal will have a definite advantage in the ever "greening" global marketplace.

Plastic, once regarded as a substitute material that is used and thrown away, is becoming one of the most durable and widely recycled materials in the industry today. Plastic products have made an impact on modern medicine, global communications, transportation and food preservation. Plastics are also used in the preservation and protection of the environment in such ways as materials recycling and pollution prevention.

Ironically, plastics, which were originally thought to be one of the larger of waste disposal problems, are now vital in the construction of material landfills. These facilities depend on plastic liners to protect groundwater by blocking toxic escape into the environment.

Plastic drainage nets and textiles are used to remove the leachate and methane gas that collects inside the landfill, while plas-

tic reinforcing materials and foam coverings save space, suppress odors and deter pests.

Plastic products also conserve energy since they are lighter than alternative materials and use less fuel to transport. Plastic building components and insulation are extremely efficient in reducing conduction and infiltration into living spaces, lowering the amount of energy used for heating and cooling. Plastics generally require less energy to manufacture than equivalent products made of alternate materials.

PVC is the world's second most widely-used plastic material. PVC, a non-hazardous white granular powder made from vinyl chloride monomer, is fabricated into diverse vinyl products having a variety of applications. Vinyl is predominantly used in construction and building applications that include window and door frames, sewer and water distribution pipe, drain, waste and vent plumbing pipe and house siding, flooring and wall coverings. Vinyl is an integral part in the manufacture of electrical wire and cable, packaging, furniture and coatings. A vast array of products found in the home and industry use vinyl products because of their unique characteristics and low cost.

Because most vinyl applications are long-term uses that are not disposed of quickly, relatively little (about two and a half percent) is found in the waste stream. Vinyl is highly recyclable and can be incinerated safely without harm to the environment. Reground vinyl is used to manufacture many items including mobile home skirting, PVC pipe and vinyl siding.

The small amount of vinyl that is discarded is also environment-friendly. Studies conducted by independent bodies, such as the New York State Energy Research and Development Authority, have shown that the presence or absence of vinyl waste in incinerator feed has no effect on the amount of dioxins produced by incinerators.* Dioxin production from any source can be minimized by carefully controlling incinerator operating conditions. Modern



pollution control equipment minimizes dioxin emissions, and scrubbers remove over 90 percent of the acid gases produced from the incineration.

Vinyl also resists attack from the corrosive action of water and soil conditions typically found in landfills. It remains inert and will not leach harmful chemicals into groundwater.

As the use of vinyl and other plastics continues to increase, so does the need for continued research to develop more and stricter recycling programs and industry regulations. The Vinyl Institute, a division of The Society of The Plastics Industry, Inc., is a national trade association that represents the leading manufacturers of vinyl plastics. The institute was established to promote and protect the growth of the vinyl industry and is actively researching ways to integrate vinyl into all phases of the solid waste management process.