"TSER—On Angle" & "IR Rejection":
Analyzing Marketing Claims

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Document Summary

Inevitably, claims will be made in the marketplace by manufacturers and retailers about the virtues of their products that allegedly distinguish them from competing products. Consumers are rarely in a position to rationally evaluate the legitimacy of such claims. What "sounds good" may have the desired "sales impact," but often "sounds" have no substance and ought not to be persuasive, simply because they are false or misleading. "Good sounding" music played during a car commercial does not prove that that vehicle performs better than some other whose musical accompaniment is less "impressive."

This bulletin analyzes recent marketing claims made in the industry regarding "Total Solar Energy Rejected—On Angle" and "IR Rejection" so that, in the future, the marketplace will be better informed about window films and better skilled at ferreting out false, confusing, and misleading claims designed to persuade by means other than transparent language, relevant scientific evidence, and rational argument. This document is not intended as a criticism or disparagement of any company or its products, but only as an assessment of certain *claims* and the evidentiary *basis* for them. The standards for evaluating product performance are an industry-wide issue and responsibility, a matter of scientific and *public* standards, not a matter of individual preference or corporate marketing strategy. To repeat, this document assesses *claims*, not the *sources* of those claims.

The Marketing Claims

Two such claims that have recently surfaced in industry literature deserve careful examination.

The first statement, or set of statements, is quoted as follows:

1. **To measure just how impressive these films are, we created a more stringent specification for their performance: Total Solar Energy Rejected – On Angle. This specification proves that our films are unsurpassed throughout the day and especially during the hottest times when you need help most. While some films claim similar performance, the fact is that their performance is only similar when tested perpendicular to the sun, which only can happen at the relatively cool times of sunrise and sunset.**

The second statement concerns "Infrared rejection":

2. **Our spectrally selective films reject up to 97% of the sun's infrared light…**

We will take up, in turn, an analysis of each of these claims.

"TSER—On Angle"

With regard to the first statement, a great many things need to be said:

1. Individual window film manufacturers are not in a position, nor are they authorized by any recognized fenestration rating agency, to independently invent or create "more stringent specifications" for their products' performance.

2. One cannot fairly use an invented comparative number to announce that one's product is better than a competitor's when that competitor does not have the testing and measurement protocols publicly available to evaluate their own products.

3. Regarding "TSER-On Angle," ***there is no such specification recognized by the NFRC*** (the National Fenestration Rating Council). What is the NFRC? To quote for their web site (www.nfrc.org):

   "NFRC is a non-profit organization that administers the only uniform, independent rating and labeling system for the energy performance of windows, doors, skylights, and attachment products. Our goal is to provide fair, accurate, and reliable energy performance ratings so that:

   • Architects, builders, code officials, contractors, homeowners, and others can compare different products and make informed product choices.
   • Building officials, state government employees, and others involved in code development and enforcement can determine if products meet local codes.
   • Government- and utility-run energy efficiency programs can establish performance requirements and standards.
   • Manufacturers have a fair and level playing field to compare products and an accurate method of showing the energy benefits of new designs or technology.

   Mission statement: *NFRC develops and administers comparative energy and related rating programs that serve the public and satisfy the needs of its private sector partners by providing fair, accurate and credible, user-friendly information on fenestration product performance.*

   The history of the NFRC reflects the general concern about providing reliable and accurate information regarding products in the fenestration industry, window products developed ostensibly to improve energy efficiency.

   What has gone on in the past, and persists to this day, is a tendency among advertisers and manufacturers to make "outlandish claims about the performance of their products." According to the NFRC, "Consumers complained, and the federal government began to investigate allegations of unscrupulous practices in the industry. … By the late 1980s, key industry stakeholders began to realize that something had to be done to prevent widespread confusion, federal intervention, and perhaps costly litigation. They came together in Vancouver , British Columbia in 1989 and founded NFRC to provide independent verification of product performance."

   For a detailed history of the NFRC and their mission, read their publication "NFRC: Behind the Glass."

   Today, more than 300 manufacturers rate and label approximately 100,000 products. Architects, builders, building inspectors, code officials, contractors, homeowners, and others use ratings information that NFRC provides. By the end of 2006 window film will be the first attachment product to be rated by NFRC.

   Why is this important for you to know? There are many reasons: Using NFRC test methods allows us to compete with the same measurements as those used by window manufacturers. It allows us to work toward participation in the US Department of Energy "Energy Star" program. NFRC has the recognized experts in the energy field supporting them including DOE, LBNL, Utility Companies, and manufacturers. This backing will allow you to fight back against some of the current "misinformation" and "outlandish claims" in the marketplace, a practice that now appears to be ongoing fully 17 years after the NFRC was established.

4. There is yet more to be said about this specific claim being made, the claim that

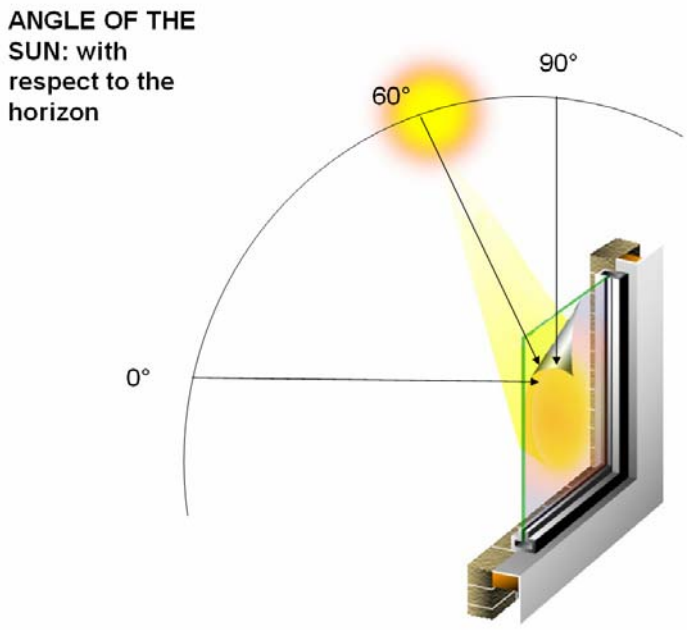
somehow "this specification *proves* that our films are unsurpassed throughout the day and especially during the hottest times when you need help most."

First, a "specification" by itself proves nothing. Characterizing a performance parameter does not prove that any film actually has a measured value. Moreover, independent testing is required for *proof* that a measured value is accurate, something difficult to provide when the value in question references a standard not recognized by the industry, neither by AIMCAL nor the NFRC.

Second, to say that a film is "unsurpassed" is not to say that it is actually *better* than any other, only that it is *not worse*. Furthermore, an assertion to that effect is a mere *claim*, not a *proof* of any claim.

Third, to say that a product "performs best when the sun is high at the hottest parts of the day" is to assert what is 1) unremarkable, 2) misleading, and 3) trivial.

It is *unremarkable* in the sense that what is being claimed is true of *all* window films; indeed, it is even true of clear glass. As you can see from the chart below, all products yield increased TSER "performance" as the sun climbs in the sky. In fact, when the sun is directly overhead (90° from the horizon), the TSER is 100%! Is this amazing? Not really. It is unremarkable because there is simply no solar radiation directly striking the window, so none gets through. The percentage of the incident total solar energy that is allowed to pass through a glazing system (TSER) does indeed diminish as the sun climbs in the sky, but this is because the solar intensity itself, with respect to the glazing surface, diminishes with the decreasing angle of incidence. The advertising claim



attempts to convince the reader that this property is a special feature of their product. It simply is not.

The claim is *misleading* because one cannot legitimately say that one's product has a TSER "On-Angle" of 75% (the angle being, say, 60° from the horizon), but that the competitor's product merely has a standard TSER of 55% at 0°, because the reference standard is not the same. Thus the claim that "While some films claim similar performance, the fact is that their performance is only similar when

tested perpendicular to the sun, which only can happen at the relatively cool times of sunrise and sunset," is a demonstrably false claim, misleading the reader to believe competitors' film *diminishes* in performance while their own film *improves* in performance, with the rising sun angle.

So we have, in the end, the *trivial* claim of "greatly improved" solar performance "on-angle." The claim would be true only because the total amount of solar energy actually coming through *any* vertical glazing system diminishes rapidly anyway as the sun climbs higher in the sky, falling to 0% solar heat gain (100% TSER) as the sun reaches an elevation of 90° (directly overhead). The claim's triviality is shown also in the case of clear (unfilmed) glass which has the same "perfect" solar performance when the sun is overhead.

5. We cannot pass over one additional confusion without a few comments to clarify the muddied waters.

   a) It is wrong to speak of "the relatively cool times of the sunrise and sunset" as if to imply that air temperature has anything to do with the intensity of radiant solar energy striking a window. The fact of the matter is that solar energy intensity ***shining on a vertical window***, on clear days, is ***greatest*** in the morning and evening when the sun's radiance is ***perpendicular to the pane***. Solar radiant energy intensity has nothing whatever to do with air temperature. Installers are well aware that thermal stress on glass is greatest on cold, clear mornings at sunrise, when the sun is shining most directly on the window. It is scientifically unacceptable to assert that a film is "performing better" when the sun climbs to a higher angle (when incident solar energy is *falling* in intensity) than when the sun is low in the sky and air temperature is "cool" (when the solar energy is actually *increasing* in intensity on the pane surface).

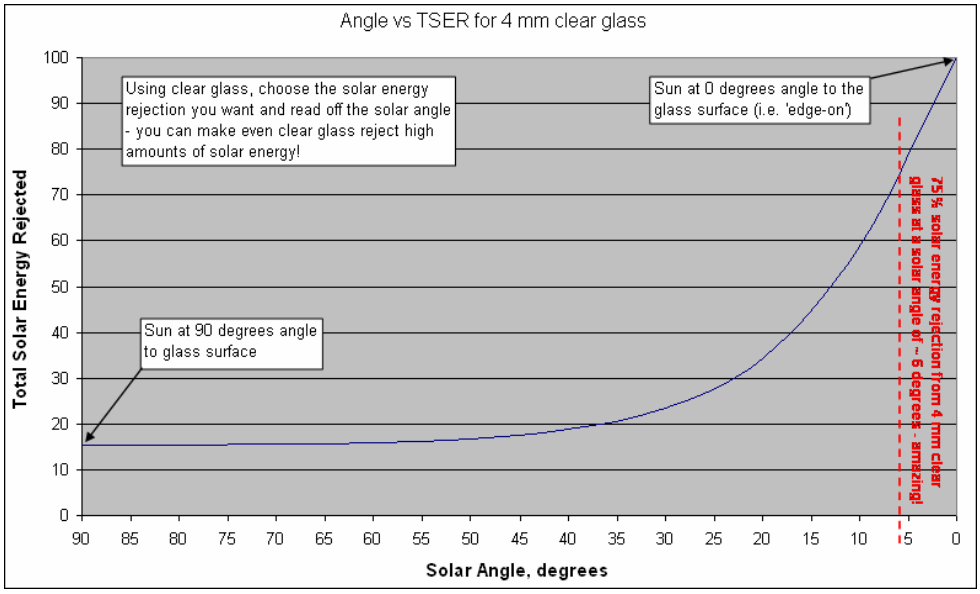
   b) It should be obvious where the source of confusion lies in this matter. On a clear day when the sun is directly overhead, its rays are passing through much less of the earth's filtering atmosphere, and thus the sun's ultraviolet, visible, and infrared radiation are much more intense, rapidly warming the ground and air. If you are lying on your back from 10 a.m. to 2 p.m., sunbathing by the pool, you feel hotter, experience tremendous glare, and are more at risk for severe sunburn. Your body, lying down at right angles to the sun, experiences the full blast of the sun, like a skylight on a rooftop. But your body is NOT a thin, *vertical* piece of glass. Vertical windows experience little to no solar radiation exposure as the sun climbs to its overhead peak. Vertical surfaces provide no target for the intense radiation to hit. This is why solar panels, to be effective at gathering sunlight, must be tilted to "face the sun," and moved as the sun progresses across the sky. It is quite true, in short, that the solar heat gain (SHG) through a horizontal window at noon is greater than the SHG through a vertical window at sunrise. But it is a mistake to assert that the performance of a filmed window somehow "improves" as the sun climbs overhead when a vertical window is progressively less exposed to this radiation. It is the drop in solar exposure that accounts for the drop in SHG, not the "improved quality" of the film.

   At CPFilms, we did our own measurements of TSER values at various angles of incidence, and these are our results, including the results for the competitive film whose maker made the claims we are examining here. We are having these results independently confirmed, even though they are entirely within theoretical expectations, and we would welcome all attempts at further laboratory corroboration. The results summarized in the following table should settle the matter:

Film Type ↓	Angle of Elevation →	0	10	20	30	40	50	60	70	80	90
VS60	VLT:	**58%**	57%	57%	56%	55%	53%	**48%**	39%	24%	0%
	TSER:	**58%**	58%	58%	59%	60%	61%	**63%**	67%	78%	100%
VS61	VLT:	**63%**	63%	62%	61%	60%	58%	**53%**	43%	26%	0%
	TSER:	**46%**	46%	46%	47%	48%	49%	**53%**	60%	74%	100%
VS75	VLT:	**74%**	74%	74%	73%	72%	70%	**65%**	55%	33%	0%
	TSER:	**40%**	40%	40%	41%	42%	43%	**47%**	54%	71%	100%
VS70	VLT :	**70%**	69%	67%	65%	64%	62%	**57%**	46%	28%	0%
	TSER :	**55%**	55%	56%	56%	56%	57%	**59%**	64%	77%	100%
"Brand X" 70	VLT :	**68%**	66%	65%	64%	63%	61%	**56%**	46%	27%	0%
	TSER :	**50%**	51%	52%	53%	55%	56%	**59%**	64%	77%	100%

Note that VS70 has a better TSER than "Brand X" at 0° (solar inclination) but that all the products rapidly become much closer in "performance" as the solar inclination approaches 90°, where all films (even clear glass, not shown) have 0% VLT and 100% TSER.

Below is a separate graph to illustrate the point, the extreme case of clear, 4 mm glass. The horizontal axis represents the solar impact angle with respect to the glass surface. Glass at right angles (90°) to the sun has roughly a 15% TSER. Not very good in the morning, you say? Wait until 1 pm when the sun rises to nearly overhead—yielding 75% TSER. Pick your time of day (or tilt the window) to give the "window performance" you want. The problem is that the total amount of energy striking the window dramatically drops as the sun strikes it more obliquely, during the "hottest" times of the day, making the window less useful for solar control.



Given these facts, the final kicker is obviously this: This specification, "TSER—On Angle," leads to the inevitable conclusion that *all glazing systems*, instead of being

"unsurpassed throughout the day and especially during the hottest times when you need help most" are, in fact, *least* effective "at the hottest times" because this is when you need help the *least*—when the sun is directly overhead and no direct solar radiance is striking the window.

Of course, window systems (including various films) are needed for other reasons: to reduce heat and glare from reflected or re-radiated solar energy, reduce thermal conductivity, provide a basic weather seal, etc. But these issues are not what is being discussed in the advertising claim.

"Infrared Rejection"

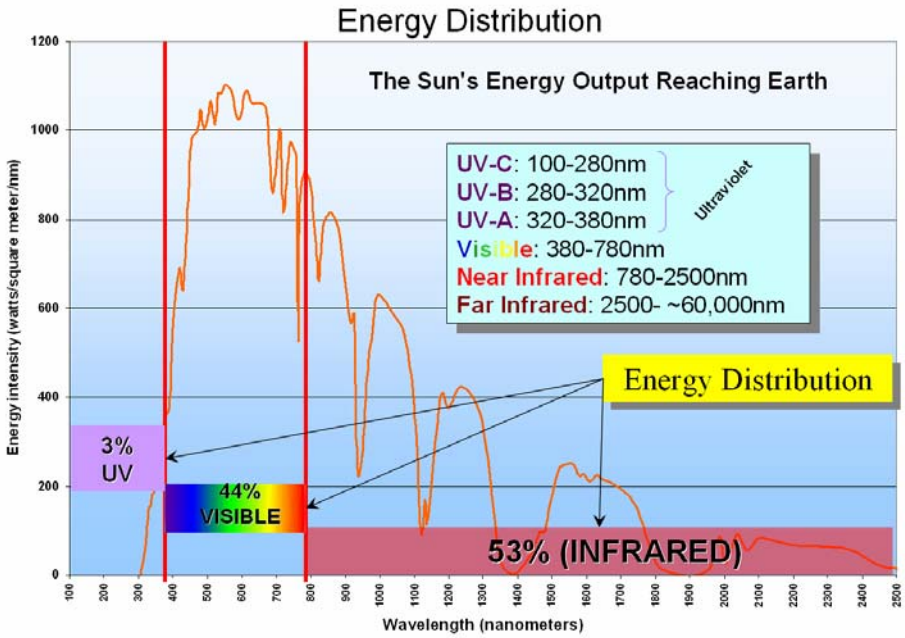
We can move now to a second important marketing claim made in the industry, the claim about "Infrared heat rejection." The claim has been made that "Our spectrally selective films reject up to 97% of the sun's infrared light… ." What exactly is this supposed to mean, and what conclusion is the consumer supposed to draw from it?

Here again we have a situation where a new parameter is being invented for the sole purpose of making one's own product appear superior to another in a way that most consumers—and competitors—have no way to evaluate. And again we note that this "specification" of infrared rejection is not a recognized standard in the industry. AIMCAL and the NFRC do not define it or specify it. Those who use it as a "marketing tool" do not often define it in any fashion that their claims can be independently tested. Often, one suspects that a specific optimum wavelength is being selected and the claim made that the film in question has a stunningly high "infrared light rejection." The scientifically minded—and scientifically equipped—person is left to discover by expensive and elaborate experimentation (analysis with a photospectrometer) that the only thing that can be meant by this is that, at a specific wavelength in the infrared band, the film has a transmission value of only 3%. But note the following:

1. One cannot deduce from a *transmission* value how much solar energy in that band is being "rejected." Absorption and/or reflection values must be known, for what is not transmitted can be absorbed, converted to heat, and conducted, convected, and re-radiated back into the room.

2. Transmission at one optimum wavelength does not inform us about what is happening at other wavelengths in the solar infrared band. In short, there are no established measurement standards universally recognized in the industry to compare disparate products for their "infrared" performance, their "*Total* Infrared Energy Rejection."

3. Nowhere in the competitive marketing literature is it anywhere explained what the connection is between "Infrared Rejection" and "Total Solar Energy Rejection." Even if we knew that ALL (100%) of the infrared was being "rejected," what would that tell us about a film's overall energy performance? It only tells is that, at best, a *portion* of the sun's total energy is being rejected.



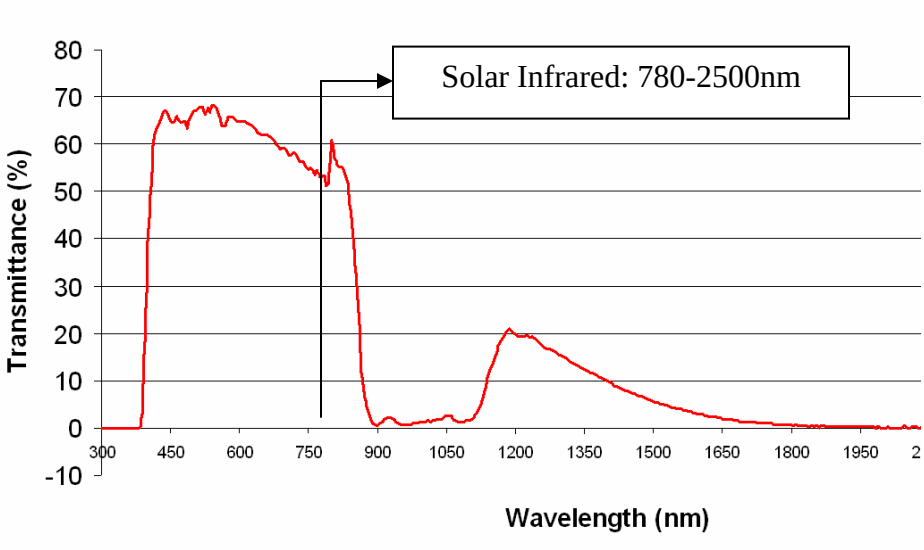
It is common knowledge among those in the industry that the composition of solar energy striking the earth is roughly divided into 3 bandwidths of electromagnet radiation whose gross energy content is distributed as follows: 3% ultraviolet, 44% visible light, and 53% infrared light, as illustrated in the above Energy Distribution diagram.

All three of these bands carry energy, exactly the *same kind of energy* (electromagnetic), most of which is converted to heat when it strikes, and is absorbed by, typical objects in a room. As shown in the diagram above, UV carries about 3% of this energy, visible light 44%, and infrared about 53% of the total amount. What we want in a solar control window film is to control the transmission & reflection of these different energy-carrying waves in differing degrees. Generally, we want to block as much **UV** as possible. We'd like to block (reflect or absorb) **glare** (visible light), in different amounts for different purposes, and certainly it is nice to block as much **infrared** as possible, for it carries a bit more than half of the sun's energy load.

So what does it mean for a film to block 97% of the infrared? It is clear that the marketing message intends to impress on the consumer the extreme high performance of this product.

1. But does it mean that 97% of the sun's "heat" is being rejected? Most people think that the sun's infrared is the part of sunlight that contains what is felt as "heat." Certainly, it is felt as heat, but so is the other 47% of the sun's light, the visible light and the invisible UV. So it cannot mean this, for nothing is being said about the remaining 47% of the sun's radiant energy.
2. Does it mean that it rejects 97% sun's *infrared* heat is being rejected? No, it cannot mean this, for there is no film or glazing product on the market anywhere that can do this currently, not even close. Blocking *transmission* of infrared generally (though not always) involves substantial absorption of energy, with consequent intrusion of a portion of that absorbed energy back into the room.
3. Does this mean that only 3% of the infrared is being directly transmitted? It might, but if so, it can only be at a few specific wavelengths in the infrared band, as our own spectrograph of this product shows. What is revealed in our laboratory analysis is that in the region from 780-1000nm, transmission exceeds 60% in the shorter wavelengths, and from 1100-1500nm transmission exceeds 20% at the peak of the "bell" curve. So there is simply no way that the claim of

97% IR "rejection" can stand up to any meaningful, non-trivial interpretation, that has any connection with something in science referred to as "the truth."



4. Finally, as a follow-up to this point about "direct transmission" of infrared, the consumer should be alert to the use of certain metering devices used to "prove" these claims. If an "IR" meter measures "3%" transmission, the first question we should ask is: What wavelength or range of wavelengths is the device sensitive to? General solar transmission BTU meters are sensitive to 300 to 1050 nanometers, far short of the full solar band which extends from 300 to about 2500 nm. And solar infrared extends from 780-2500 nm. We cannot rely on a measuring device until we know what it is measuring. An "IR meter" might be selectively sensitive, because of the filter it is using, to an extremely narrow band of radiation, say around 1050nm. So all the questions raised in the preceding 3 points must still be addressed. No conclusion can be made about how well a given product performs against another at reducing the solar heat gain or its overall "energy performance." *Total solar energy rejected* (or, conversely, the *solar heat gain coefficient*) must be measured, and by standards and methods that are independently established by the appropriate regulatory agency.

Summary 1 (Technical)

In summary, concerning "IR rejection" and "TSER On Angle" we can say the following:

1. There are no recognized quantitative specifications for "IR rejection" and "TSER On Angle" in the glazing industry, and are not likely to ever be in the foreseeable future. The former term both technically undefined and not informative of the total energy performance of the window. The latter term is misleading, falsely implying that windows, and window films, perform better in some meaningful way as the radiation striking them falls in intensity (as the sun climbs in the sky).
2. If claims are being made about the energy performance of window films (and glazing systems in general), TSER or its complement, the Solar Heat Gain Coefficient (SHGC), should be used. SHGC is already the NFRC standard in the glazing industry, and is simply the term designating the percentage of ***total*** solar energy (UV, visible, *and* IR) that strikes a glazing system that is allowed to pass through that system (measured, incidentally, when the incident radiation is at right angles to the glass).
3. Claims about IR rejection must be qualified in the context of visible light transmission and overall SHGC. Many spectrally selective films do a good job of blocking a great percentage of IR energy while allowing more of the visible light

to pass through. Since higher light transmission also means higher *heat* transmission, one must be alert to what is happening to the SHGC, and make film selections based on VLT, SHGC, appearance, price, warranty, the manufacturer and installer's quality & reputation, and, of course, the legitimacy of the various marketing claims made on their behalf.

Summary 2 (For conversation starters with consumers)

1. "TSER—On Angle" is not an industry-accepted measure of a film's performance and therefore cannot be used to assert the superiority of one film product over another. The NFRC is the only independent agency to rate window performance, and "TSER—On Angle" is not recognized by them as a measure of performance.
2. All film products, indeed all glazing systems, have improved "total solar energy rejection" as the sun climbs higher in the sky and sunlight strikes a vertical glass window less directly. When the sun is directly overhead, all vertical windows (with or without film) have 100% total solar energy rejection.
3. Sunlight (solar radiation) is made up of 3% ultraviolet, 44% visible light, and 53% infrared energy, and ALL of this energy generates heat if it enters a room through a window. Blocking 97% of the infrared would NOT block 97% of the heat, but only 97% of 53%.
4. No window film, in fact, blocks 97% of the sun's infrared energy. Blocking 97% of the infrared at a single wavelength does not mean that all the other wavelengths of infrared are being blocked at that level. Be skeptical of metering devices that selectively measure at very narrow wavelength bands, for they can falsely represent the whole picture.

IMPORTANT NOTICES:

CAUTION: Tinted motor vehicle windows must comply with local laws. Dark tinting may reduce outward visibility during poor lighting conditions. Use care to avoid accidents.

CAUTION: Do not apply residential / commercial film to plastic surfaces such as acrylic (Plexiglas™) or polycarbonate (Lexan™) sheeting (unless the film is designed specifically for that purpose) or to motor vehicle windows.

CAUTION: Always test glass surfaces for susceptibility to scratching before cleaning with metal tools. Soft glass, some types of tempered glass, and sputtered/low-e coatings may be damaged by defective, rusty, or nicked blades, or by applying excessive force to scraping tools. Be prepared to use non-scratching fabrics/pads for window preparation.

CAUTION: Always use absorbent dropcloths to protect sensitive surfaces from overspray, drips, or runs when cleaning windows and installing films.

All statements and recommendations in this document are based on tests and information the CPFilms Inc. believes are reliable and are offered in good faith. CPFilms Inc. cannot warrant or guarantee the accuracy or completeness of this information nor its relevance for a particular user's situation. It is essential that the user evaluate this information to determine its suitability for a given application.

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