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Mark Parlee **7322 Oakwood DR.** **Urbandale, IA 50322**

Date: February 18, 2010

To:
[redacted]
4301 [redacted]
URBANDALE, IA 50323-2499

Purpose and Scope:

The purpose of this consult visit is to evaluate the thermal distortion of the vinyl siding on this home and describe the cause and effect.

General Information:

I made four site visits to investigate the cause and effect of the thermal distortion occurring to the vinyl siding on this home, hereinafter referred to as 4301; the house that has the windows that are reflecting onto 4301 will be referred to as 4307. The north garage wall on 4301 gets the most thermal distortion and extends from a point 12" up from the bottom of the vinyl to an additional 6'-6" up the wall. The entire length of the garage siding is effected. This is a winter season event as the sun is at a lower angle. There are three spots about 6" square that move across the siding in the opposite direction of the sun. They correspond to three windows on the south wall on 4307.

I took some temperature readings on the face of the vinyl. This temperature drops very quickly as the shadow of my instrument and hand blocks the sun. These temps were taken on a day with 10 degree ambient temperature. I had one that exceeded 200 degrees but only was able to capture 177 degrees in a photo. On the same day I looked at a few other homes in the area that also had reflections from neighboring homes, to compare info. The glass on another home that was reflecting was larger 24 x 48 and only yielded a temperature of 37 degrees on the neighbor's home. It appears the smaller the glass size the more focused the reflection potential.

In my research on these types of problems I find it is an occurrence that some in the industry refer to as rare. A statement from the Vinyl Siding Institute (VSI) does acknowledge this event and made a statement on it in February 2002. For being a "rare" occurrence, there is plenty of information on this phenomenon from various glass companies and VSI.

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The solutions being suggested to keep this from affecting the siding are as follows:

Install a screen in window causing the problem.

Install an awning over the window to break line of light reflection.

Use shrubbery to protect area of siding from reflections or radiation.

Mike's neighbor across the street at 4300 had a solution for this same problem by building a wood fence next to his house covering the affected portion of the siding. His effected area is a lot less than the one on 4301 and if this were considered as a solution it would have to cover the entire side of the garage wall and continue across the part of the house wall that is being thermally distorted as well. The awnings may look odd and out of place on 4307. The shrubbery would have to be tall, and may constitute a problem if there any covenants or easements. Also in speaking with Mike he has noticed heat distortion on the grass during the summer months so this may have a detrimental effect on any shrubs.

In my opinion the best place to start for a solution to this problem would be to try screens on the offending windows to diffuse the intensity of the reflection.

Attached to this report is a Technical Service Bulletin from Cardinal Glass Company that describes this problem in more depth.

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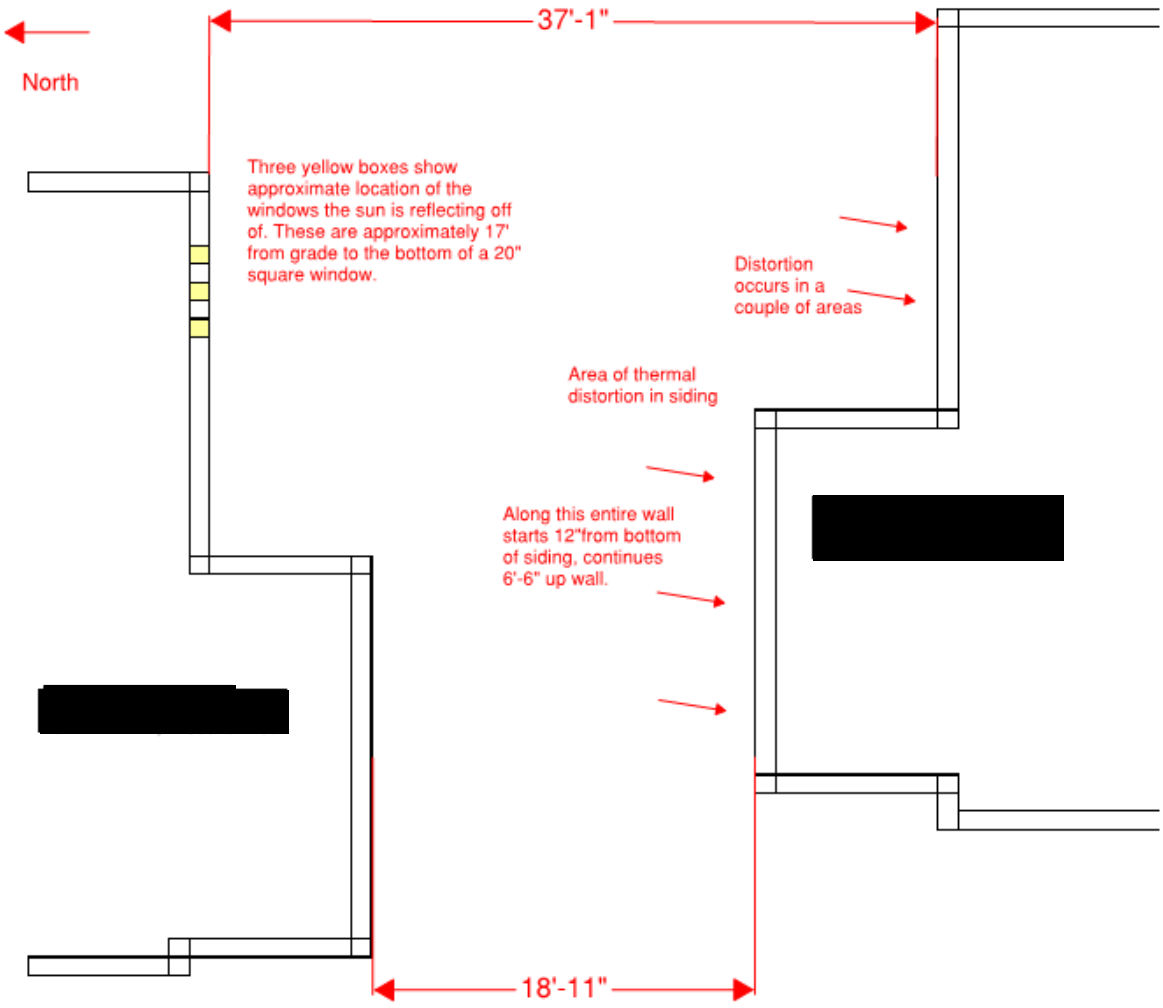

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The three small windows on the home directly to the north are the windows the sun is reflecting from to cause the thermal distortion.

The reflection from 4307 is transmitted to a 6” to 8” square on 4301 that moves in conjunction with the suns movement.

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This reading of surface temperature was taken on December 31st 2009.
This is a reading of 177 degrees F.
The ambient air temperature was 10 degrees F
Vinyl siding thermally distorts at temperatures above 160 to 165 degrees F according to VSI (vinyl siding institute)

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This view shows the effects of the thermal distortion on the siding on the north side of the garage.

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These photos are of another home in the area that has somewhat the same positioning of structures and window placement.
Notice that the reflective spots are not as small or as intense in temperature. This is due to the windows glass of the reflecting windows being larger in overall dimensional measurement.
The parabolic amplification of the light is not as focused so the heat magnification is substantially less and does not get close to the temperature needed to cause thermal distortion in the vinyl siding.
This temperature reading is only 37 degrees. This reading was taken within 1/2 hour of the reading I took on Mike's home. There are numerous homes in the area that have this event happening but with larger windows it does not appear to be problematic

Vinyl Siding Distortion

The Vinyl Siding Institute in February 2002 issued the following warning about vinyl siding distortion.

The Vinyl Siding Institute (VSI) is aware of rare incidents of thermal distortion of vinyl siding due to reflected light of radiated heat. In such incidents, reflected or radiated heat from various sources combines with ambient temperature and sunlight, to cause visible distortion of vinyl siding panels. The typical heat distortion temperature of rigid vinyl (PVC) siding is 160-165°F. Once this temperature is reached, the siding may distort.

While excessive heat buildup leading to thermal distortion cannot always be predicted, being aware of the factors that contribute to it may help to avoid it. Reflected or radiated heat sources have been reported to include window, glass doors, roofing, and pavement. These sources combined with architectural characteristics such as alcoves that block breezes, overhangs that trap convected heat and inside corners that capture window reflections result in thermal distortion.

Thermal distortion will usually reoccur in the same location unless preventive measures are taken. The VSI recommends that damaged siding panels be replaced and that homeowners be advised to take preventive measures to eliminate reoccurrence. Some examples of preventative measures are the following:

- *Install screen in window causing the problem*
- *Install an awning over the window to break line of light reflection*
- *Use shrubbery to protect area of siding from reflections or radiation*

Our research of the potential for glass products to produce a reflected image that increases temperatures on vinyl siding, confirms the VSI's warning. Listed below are many variables that contribute to potential heat build up on vinyl siding. These variables include, but are not limited to:

- Outdoor temperature and wind speed.
- Proximity of other heat sources, such as air conditioning compressors.
- Color and solar absorption of the vinyl siding.
- Heat distortion temperature of the vinyl siding.
- Architectural designs which block wind and trap heat.
- Angle of the sun in relation to the glass product.
- Orientation of the glass product relative to the sun and the vinyl siding.
- Distance of the glass product to the vinyl siding.
- Solar reflectivity of the glass product.
- Deflection of the glass product.

Analytical Considerations

- **Vinyl Siding Absorption**

Vinyl siding comes in a variety of colors, each having its own solar absorptance. The values seldom exceed 80% or are less than 20%. As the solar irradiance level incident on vinyl siding increases, the siding will heat up. Fig. IG14-1 below indicates the surface temperature of the siding at various levels of solar irradiance for vinyl absorptances of 20% and 80%. The average solar irradiance from the sun in the middle of a clear day would be approximately 1,000 Watts/m². For a vinyl solar absorptance of 20%, the vinyl siding temperature would be 100°F; for a vinyl solar absorptance of 80%, 150°F. There is a direct correlation between vinyl solar absorptance and the temperature of the vinyl. For a vinyl absorptance of 50%, the temperature of the vinyl siding would be 125°F. VSI warned that vinyl siding can distort at temperatures as low as 160°F.

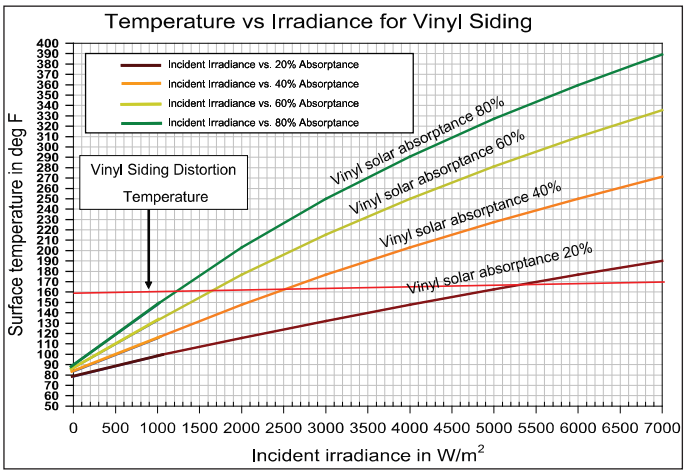

Fig. IG14-1 Plot of vinyl siding surface temperature as a function of incident solar irradiance for four different siding solar absorptance values.

- **Glass Solar Reflectance vs. Siding Temperature vs. Glass Deflection vs. Glass size.**

Figures IG14-2, IG14-3, IG14-4, and IG14-5 show the temperature expected on vinyl siding having absorptions of 20 % and 80% with glass deflections varying from 1mm to 4 mm, for a 24" square insulating glass unit and for a 24" x 48" unit. For clear glass, the solar reflectance is 13%; for Cardinal's LoE²–272™ coated glass product, the solar reflectance is 35%. The data indicate the following:

- A square glass unit will produce a higher temperature on the siding than a unit with an aspect ratio of 2:1. A non square unit creates an elongated reflection on the vinyl siding, while a square unit creates a smaller more focused reflected beam.
- Vinyl siding with an 80% absorptance results in approximately a doubling of the vinyl temperature compared to vinyl siding having an absorptance of 20%.
- Our research shows that vinyl siding with relatively high solar absorptances have the potential for distortion from solar reflections from all glass products, including clear glass.

Vinyl Solar Absorptance = 20%

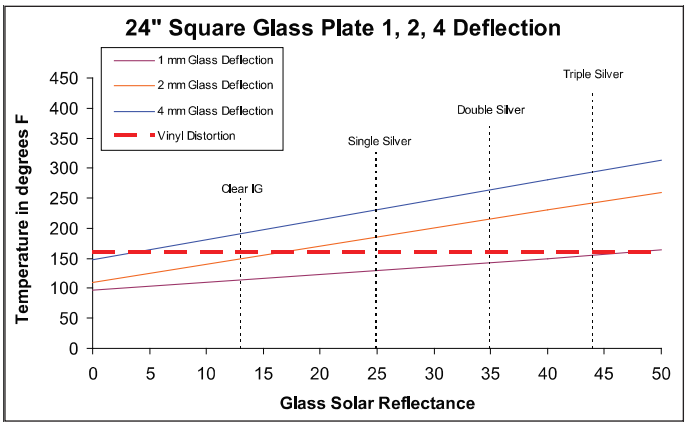

Fig. IG14-2 Vinyl siding temperature versus glass reflectance in % for various glass center deflections and for vinyl solar absorptance of 20%

Vinyl Solar Absorptance = 80%

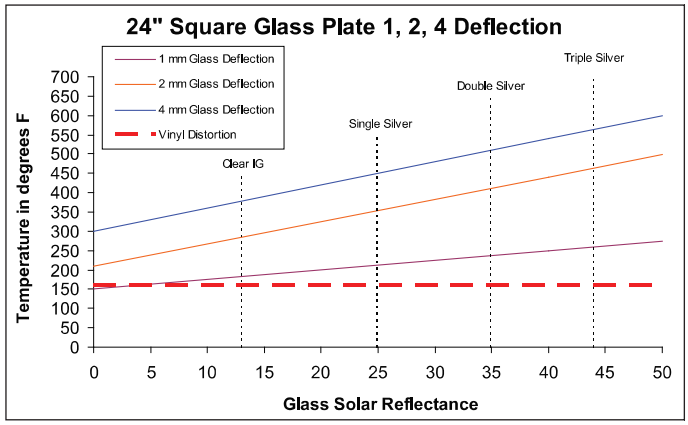

Fig. IG14-3 Vinyl siding temperature versus glass reflectance in % for various glass center deflections and for vinyl solar absorptance of 80%

Vinyl Solar Absorptance = 20%

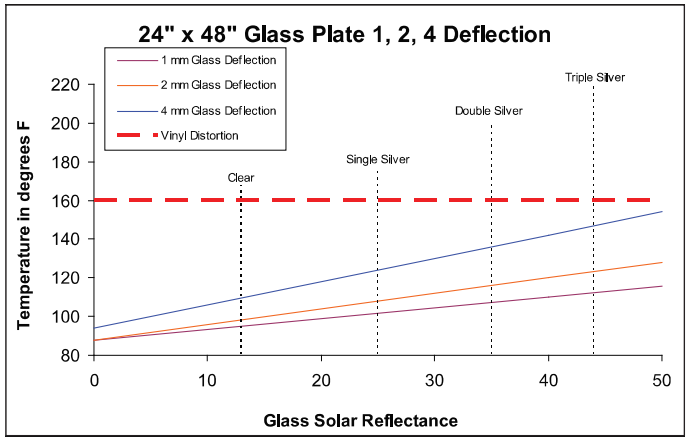

Fig. IG14-4 Vinyl siding temperature versus glass reflectance in % for various glass center deflections and for vinyl solar absorptance of 20%

Vinyl Solar Absorptance = 80%

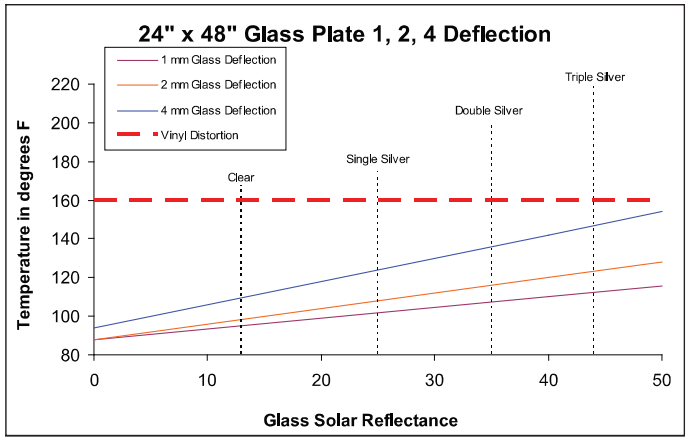

Fig. IG14-5 Vinyl siding temperature versus glass reflectance in % for various glass center deflections and for vinyl solar absorptance of 80%

- **Glass Reflectance vs. Angle of Incidence**

Figures IG14-6 and IG14-7 indicate the solar reflectance off of Clear Glass and Cardinal's LoE²-272™ coated glass products as a function of the sun angle to the glass. As can be seen for both of these glass products, the higher the angle, the higher % solar reflectivity off of the glass. This is important as with high angles of incidence, the potential for a higher reflectivity and higher vinyl temperatures can occur.

Fig. IG14-6 Optical Properties for Glazing System (Clear Glass)

Angle	0	10	20	30	40	50	60	70	80	90
Solar Reflectance	0.128	0.128	0.128	0.130	0.139	0.164	0.227	0.365	0.612	1.000

Fig. IG14-7 Optical Properties for Glazing System (LoE²-272)

Angle	0	10	20	30	40	50	60	70	80	90
Solar Reflectance	0.348	0.342	0.341	0.343	0.351	0.367	0.397	0.469	0.639	0.999

Summary and Conclusions

- As VSI said in its warning, vinyl siding has a relatively low heat distortion temperature (160°F). When this temperature is reached on the siding it can distort. Reflected or radiated heat sources, i.e. windows, doors, roofing, and pavement could reflect enough energy from the sun to produce temperatures on the vinyl siding that could produce distortion. In addition, outdoor grilles adjacent to vinyl siding can produce temperatures high enough to cause vinyl siding to distort.

- Darker more absorptive vinyl siding will have more potential for distortion from the absorption of solar reflections off of building materials than lighter colored vinyl siding.

- There are more homes being built with darker siding. In the past most of the homes being built with vinyl siding distortion were built with white vinyl siding. The newer homes are being built with beige and gray color siding which is considerably more absorptive than white, which raises the vinyl siding temperature when exposed to direct or reflected sunlight.

- Architectural design is a factor. Alcoves that block the wind, overhangs that trap convected heat and inside corners that capture glass reflections can contribute to the circumstances leading to thermal distortion of vinyl siding. Also, alcove or cubby areas can put glass at a 90 degree angle to vinyl siding. This results not only in direct sunlight on the vinyl siding, but also reflected light off from the glass.

- Radiation from the sun which strikes a glass surface at a large angle and reflects onto nearby vinyl siding can add to the existing unreflected solar radiation. The large angle of incidence on the glass product means its reflectivity will be higher, further concentrating the effect of the sun's heat on the vinyl siding.

- Glass products with solar reflections higher than clear glass have more potential to create higher vinyl siding temperatures. Legislation requiring window manufacturers to meet energy codes, provide comfort in winter and summer, and reduce energy consumption in homes has fostered and can be expected to accelerate the proliferation of Low-E glass products with higher solar reflectivity than clear glass. Users of vinyl are on notice from the VSI's warning that vinyl siding is more susceptible to distortion from reflected solar radiation than more robust building materials. The risk of distortion is inherent in the use of vinyl siding as a building material in the modern energy use sensitive environment.

- Properly manufactured insulating glass units may have exterior lites that are concave, flat or convex. Units that have a concave exterior lite (deflected) may focus reflected solar radiation more intensely increasing the temperature of the radiation over the focused area. Square deflected units can create more focused energy and higher vinyl siding temperatures than non square deflected units. Because insulating glass units are hermetically sealed, depending on glass thickness, airspace thickness, size of the units, barometric temperatures and outdoor temperatures, and fabrication tolerances, glass deflections can naturally occur. For example, during winter, colder temperatures cause sealed insulating glass units to deflect inwards.

As the VSI has warned, vinyl siding is vulnerable to heat distortion. Our research has shown this vulnerability to be different and much greater than other siding products. Metal and wood siding products react adversely to reflected solar radiation only at far higher temperatures.

Users and their builders who want to use vinyl siding should examine their building site carefully before the installation. The presence of reflected solar radiation on existing materials is a warning that vinyl distortion is likely. The presence of exterior heat sources, alcoves, overhangs, etc. should also be carefully evaluated. The user should discuss with their builder and consider selecting a vinyl material that has the highest possible heat distortion temperature, solar reflectivity and/or lightest color.

Many Vinyl Siding Manufacturers add pigment into the vinyl siding to reflect infrared energy. This new development is claimed to reflect solar heat build up in vinyl siding and should reduce the potential of vinyl siding distortion.

If a user experiences vinyl siding distortion, whether or not the user has properly managed the risk of heat distortion inherent in vinyl siding, the VSI's recommendations of installing screens or awnings over the relevant glass products or using shrubbery to block reflected solar radiation should be considered and followed. If the relevant insulating glass unit is significantly deflected, the unit may be vented to reduce focused radiation, but it should not be expected that venting a deflected unit will resolve the risk of distortion if other conditions are present to create elevated temperatures on the vinyl siding i.e. exterior heat sources, alcoves, overhangs, etc. that trap convected heat and inside corners that capture reflections from glass products or other building materials.

Note: This report was based in part on work performed under contract by Dr. Ross McCluney of the Florida Solar Energy Center.