APPENDIX A

DISCUSSION OF DOW INSTILL VACUUM INSULATION CORE

The discussion in this appendix of technical issues related to performance is based on information provided by DOW staff. No original tests were conducted by the Research Center to develop or verify the information.

INSTILL Core from DOW has several advantages over conventional core materials. It is lightweight and can be produced at a relatively low cost compared to other materials, and the resulting panels have extremely high thermal resistance. The fabrication costs for VIPs are also reduced with the INSTILL Core. Several factors contribute to the reduced fabrication costs associated with the use of this core material including:

- Low Moisture Content
- Unique Foam Cell Structure
- Reduced Dusting during Fabrication

Moisture Content

Most core materials contain some moisture after production. To remove this moisture, these core materials are heated in a desiccant bed oven at approximately 160 degrees Fahrenheit for an extended period of time. The INSTILL Core has very low moisture content and does not require the preconditioning that other core materials require. Even in high humidity, INSTILL Core will only adsorb a maximum of 0.05 wt. % of water which is readily absorbed by a suitable desiccant. During VIP fabrication, desiccants like calcium oxide are generally installed in recesses located in the core to extend the panel's useful life by absorbing residual moisture and the moisture that enters after fabrication. The INSTILL material requires no preconditioning or drying unless the material becomes wet during storage. These factors reduce both the time and expense in the fabrication process of VIPs.

Unique Foam Cell Structure

The INSTILL Core is composed of a unique open-cell, microcellular polystyrene foam board patented and produced by DOW. Due to the unique structure of the INSTILL Core material, the panel can achieve higher R-values at moderate pressures than all other core materials with the exception of silica. However, silica presents other fabrication challenges that limit its viability in some applications. Described in another way, at R-25 per inch the unique cell structure of INSTILL Core can tolerate at least 40 times more "vacuum depleting" molecules inside the VIP than polyurethane while maintaining a better thermal resistance.

Reduced Dusting during Fabrication

The INSTILL Core material is currently produced in twenty-four inch by ninety-eight inch panel sheets. INSTILL boards are typically cut and shaped using either a band-saw or a hot-wire cutter. Unlike other conventional VIP core, the INSTILL material cuts easily with minimal dusting. This means that clean-up time is reduced and that it is easier to keep the seal areas of the panel clear of debris. Reduced dusting also results in less wear on manufacturing equipment and less dust exposure to personnel.

Life span of VIPs Made with DOW's INSTILL Core

Even though INSTILL Core VIPs have a long life expectancy compared to many other VIPs, a typical VIP’s life span may be much shorter than traditional insulating materials used in

residential construction. Some degree of uncertainty surrounds estimates of the life expectancy of all VIPs, including those made with INSTILL Core.

APPENDIX B

MARKET ASSESSMENT OF 10 SELECTED APPLICATIONS

A description of each of the ten selected applications, their potential benefits and limitations as identified in the analysis, and estimates of market potentials follow.

Precast Concrete Panels (Foundation/Wall)

Description of Application

Several manufacturers currently produce precast concrete panels that incorporate expanded polystyrene insulation (EPS) panels. Insulation board is cast between a one-inch thick exterior concrete skin and concrete studs. A concrete top and bottom plate is used to tie the exterior skin and the concrete studs together. These foundation systems are typically used for basement foundations, but most manufacturers also produce panels that can be used for crawlspace foundations. VIPs could be used to replace the current EPS insulation.

Benefits

If VIPs are adopted, they could be incorporated into these systems using currently available manufacturing processes. Typically, basement walls have fewer penetrations than above-grade walls. This practice means that builders could use large panels, which should reduce the per-square-foot manufacturing costs of VIPs for this application. Also, by casting the VIPs into panels in a controlled manufacturing environment, the risk of damage to the barrier film during construction is reduced. Basement walls are typically required to have an R-5 blanket insulation attached. Pre-cast foundations currently meet that requirement with the EPS insulation. Incorporation of VIPs, with thermal resistance in excess of R-20, could have a significant impact on the energy efficiency of basement walls and the house as a whole. Also, since the stud space will not be needed for insulation purposes, the thickness of foundation walls could be optimized.

Limitations

Although casting the VIP into a concrete panel will greatly decrease the potential for damage during construction, the interior barrier film would be left exposed. This practice might result in a substantial risk of damage by a homeowner after construction is completed. DOW engineers indicated that adhering a thin layer of a paper based panel product or DOW STYROFOAM product to the interior of the product might reduce the risk.

The most significant drawback to incorporating VIPs into foundation walls is the uncertainty over the life span of VIPs. DOW engineers indicated that panel life can be increased with the incorporation of additional desiccants into the panels and the use of different barrier films. In addition, though no testing has been performed, DOW engineers indicated that the combination of a concrete skin and the interior protective layer might extend the life of the panel.

Potential Market Size

Data from the U.S. Bureau of Census indicates that almost 1.5 million new houses were started in 1997. Based on 1997 builder survey data, a little over one-quarter of them, or about 400,000 new homes, is estimated to have had full basement foundations. Houses built on basement

foundations may represent a potential market of hundreds of millions of square feet of basement wall.

Pre-cast basement walls are not yet widespread in the residential sector. Less than one percent of new SFDs built in 1997, or a little over 1,300 homes, were constructed using this technology. Assuming that these houses had an average of 128 linear feet of basement wall, they accounted for almost 1.4 million square feet of basement wall. No instances of the use of precast foundation panels in either single-family attached or multifamily housing units constructed in 1997 were identified.

Although precast foundations currently have limited use in residential construction, they are relatively new to the market. Cycle-time has become increasingly important in production home building. Pre-cast foundations have significant advantages in cycle-time compared to other foundation types. Demand for precast foundations should increase in the future. If that occurs, the market for VIP-insulated pre-cast foundation panels may grow as well. For example, if they capture just a one-percent share of detached single-family starts, precast panels could account for about 10 million square feet of basement wall annually.

Manufactured Housing Floor Panels

Description of Application

Floor insulation for manufactured homes is often located below the floor framing and above a protective mat at the chassis level. The mat is used to protect the underside of the unit during transport to site. This application involves the incorporation of VIPs into the protective mat to serve as the floor insulation for the unit.

Benefits

Due to the uniform nature of manufactured housing, this application can entail the use of large panels that should lower the per-square-foot manufacturing costs of VIPs for this use. The high insulating value of VIPs also has the potential to significantly affect the thermal performance of the building envelope. The controlled environment in which manufactured homes are produced should help minimize the potential for damage to the barrier film during construction. Since occupants rarely alter the undersides of manufactured homes, the risk that they might damage the panels is thought to be minimal.

Limitations

The most significant limitation regards the life span of the VIP panels. Currently, a new manufactured house is expected to last 50 years or more. Efforts to ensure that the life of VIPs meets the demands of this application will be required. Any significant uncertainty, both real and perceived, regarding the panel's life expectancy will need to be addressed.

Potential Market Size

As can be seen in Table B-1, the number of units shipped for residential use has increased between 1991 and 1997. Approximately 354,000 manufactured housing units were shipped in 1997. This is an increase of over fifty percent in the number of units shipped compared to 10 years earlier. It should be noted that during this period manufactured houses were also growing as a share of the housing market.

Around fifty-seven percent of manufactured houses are double-wide units. Data in *Factory and Site-Built Housing, A Comparative Analysis* indicates that in 1996, single-wide manufactured homes had an average of 1,056 square feet of floor area, and double-wide manufactured homes had 1,629 square feet. Combining these sizes with the 1997 data on the number of units shipped yields an estimated 489 million square feet of floor area placed in 1997.

TABLE B-1
Manufactured Housing Shipped for Residential Use (1,000s)

	1981	**1987**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Single Wide	181	144	94	113	133	156	174	174	152
Double Wide	60	88	77	97	122	149	167	189	202
Total	241	232	171	210	255	305	341	363	354

Panels Laminated to Gypsum Board for Manufactured Housing Ceilings

Description of Application

Gypsum board ceiling sheathing is frequently attached to the roof frame using adhesives rather than mechanical fasteners. In this application, VIPs would be laminated to the gypsum board to produce a composite product that provides attic insulation and ceiling finish material.

Benefits

Representatives from DOW indicated that the lamination of gypsum board to VIPs would not be extremely difficult. The repetitive nature of manufactured housing would allow standard sized panels to be planned and produced. They could be constructed to accommodate penetrations and thus minimize the potential for damage to the barrier film. Because the environment in which manufactured homes are produced is highly controlled, the risk of damage on the jobsite is minimal. By installing the insulation and the gypsum board at the same time, added installation costs associated with handling the material might be offset by a reduction in insulation installation time relative to conventional practices. The high insulation value of VIPs could have a significant impact on the overall thermal performance of units.

Limitations

The most significant potential limitations associated with this application include the life span of the panels and the risk of damage by occupants after construction. Currently, a new manufactured house is expected to last 50 years or more. Efforts to ensure that the life of VIPs meet the demands of this application are required. Any significant uncertainty regarding the panel's life expectancy needs to be addressed. Occupants would have to be instructed not to penetrate the ceilings of the units to minimize the chance of damage to the barrier film of the panels. Consideration must also be given to the ability of the barrier film to support the weight of the gypsum and its ability to maintain the connection with framing members.

Potential Market Size

See Potential Market Size section of the discussion of Manufactured Housing Floor Panels.

Insulated Metal Roofing Panels

Description of Application

Metal roofing panels are often produced with insulating cores and painted metal skins that serve as finished surfaces. These panels are frequently used in commercial construction. They typically are fastened to the steel superstructure to provide finished wall and roof surfaces. These panels are capable of spanning up to eight feet between horizontal load bearing purlins. Recently, there has been an increasing interest in metal roofing for residential applications such as cathedral ceilings.

The evaluation team felt that VIPs could be incorporated into the foam core portion of the panels. Even a thin VIP should significantly increase their R-values so that it would be possible to reduce the thickness of the overall insulation panel and still maintain the required thermal resistance.

Benefits

Large VIPs could be incorporated into metal roofing panels using current VIP manufacturing processes to lower per-square-foot manufacturing costs. Metal roofing panels are sold in packages which are designed to minimize or eliminate field cutting of the material. This practice makes it possible to insert VIP panels into the roof panels during manufacture to minimize the possibility that the barrier will be punctured during field cutting.

The incorporation of VIPs would make achieving high R-values possible and allow manufacturers to produce roof panels with a relatively small cross-section.

When roofing panels are used as roof framing, a false ceiling is sometimes framed to provide a location for HVAC ducting and electrical wiring. This practice should minimize the amount of penetrations in the panels and reduce the potential of damage to the barrier film both during and after construction.

Limitations

The most significant limitation in incorporating VIPs into roofing applications is the potential variability in the life span of the material. However, DOW representatives indicated that because the VIP would be encapsulated in a foam core, current estimates might understate the life span of the VIP. Testing of the material to develop accurate estimates on the life span of a VIP under such conditions is needed.

Potential Market Size

Insulated metal roofing panels are not currently used in residential construction. However, non-insulated metal roofing is increasing in popularity among both builders and homeowners. Steel roofs are estimated to have accounted for almost one percent of the estimated three billion square feet of roofing material used on new houses in 1997. One implication of the growing popularity of this material is that consumers seem increasingly comfortable with the appearance of metal roofs.

In residential applications, metal roofing is most commonly installed over plywood sheathing nailed to roof trusses. Metal roof panels would make other approaches possible since the panel's structural characteristics might make sheathing unnecessary. For example, "truss-and-purlin" framing would allow the builder to realize cost savings from the omission of sheathing. While this framing method can be found in the light commercial market, this technique is not frequently encountered in American residential construction. An alternative roof framing approach that is sometimes encountered in residential construction is "beam-and-purlin" framing. This niche market would allow builders to use the panels and still save the cost of sheathing. Builder survey data on roof framing methods shows that beam-and-purlin construction represents only 0.18 percent of new houses.

Other data from the survey indicate that roof pitches between 5/12 and 6/12 are the most common geometries in detached single-family houses. The same data indicates that the average size of a detached house was 2,045 square feet. Assuming this house to be a two-story detached house with approximately 135 linear feet of exterior wall and a roof pitch of 5/12, almost 1,500 square feet of roofing material would be needed. About four million square feet of roofing would be needed for the houses constructed with beam-and-purlin framing in 1997.

Exterior Doors

Description of Application

Over the past 30 years, insulated exterior doors have become the standard for residential construction. Insulated exterior doors are produced using three common skin types: wood, steel, and fiberglass. Steel insulated doors dominate the residential market due to their relatively low cost. The core material for insulated doors is typically composed of extruded polyisocyanurate. The R-values of exterior doors range from 5 to 7.

This application would entail the incorporation of VIPs into the core material of insulated exterior doors. Even a thin VIP would drastically increase their thermal performance.

Benefits

VIPs could be incorporated into these doors using currently available manufacturing processes. Because exterior doors are produced in relatively few sizes, mass production of standard size VIPs should help reduce manufacturing costs. Incorporating VIPs into exterior doors would dramatically increase their thermal resistance. Next to windows, exterior doors are the most notorious weak spot in the thermal envelope. The R-value of VIP-insulated doors could easily match or exceed that of conventionally insulated walls.

Because most exterior doors are pre-drilled for lock sets and pre-hung in a frame, the risk of damage during construction would be minimized. A door containing VIP should require no special handling or installation practices, and thus should not cause any increase in installation costs.

Unlike many of the other applications, exterior doors are often replaced during the life of a house. Thus, the limited life span of a VIP is not a major issue. Also, the insulated value of the VIP core material is similar to that of conventional door core materials. Thus, even if the barrier film is compromised, the overall R-value of the door will be no worse than that of a conventional door.

Limitations

No significant limitations were identified with the use of VIPs in exterior doors; however, homeowners should be cautioned not to install accessories with screws long enough to penetrate the barrier film.

Potential Market Size

In 1997, approximately 3.5 million exterior doors were installed in new housing units nationwide. Almost 90 percent of them were estimated to be either steel or fiberglass, the materials that might be best suited for this application. Assuming an average door height of 6 feet 8 inches and a width of 3 feet, steel and fiberglass doors account for over 60 million square feet of door surface.

An estimated 2.8 million exterior doors were purchased for repair and remodeling in 1997. Steel and fiberglass doors represent over 70 percent of the market, so these doors are estimated to account for over 40 million square feet of door surface.

Garage Doors

Description of Application

Insulated metal garage doors are increasingly popular. This application would involve the incorporation of VIPs into the foam cores located within the panels of a metal garage door.

Benefits

VIPs could likely be incorporated into garage door panels using current manufacturing processes. Garage door sizes are fairly standardized, so the mass production of panels in a few sizes would allow manufacturers to capitalize on economies of scale to reduce per-unit manufacturing costs. Because no substantial change to the dimensions, weight, fittings or the exterior shell of garage doors is expected, no additional installation expenses are anticipated.

Unlike many components of houses, garage doors are easily replaced. This means that the limited life span of the VIPs is not as likely to be as significant an issue as it would be with other components. Also, assuming that the garage door panels are predrilled and fitted with the necessary hardware, no further penetrations of the surface would be required for installation. For this reason, little risk of damage to the VIPs during construction seems to exist.

Limitations

Although insulated garage doors are gaining ground in the market, most garages are not conditioned. The walls separating the garage from the living spaces are most frequently insulated, so that the addition of VIPs would have little impact on the typical home. A garage door is likely to be subject to many impacts that could damage a VIP, so the danger of breaking the panel's vacuum was seen to be a major issue.

Potential Market Size

According to *Annual Builder Practices Survey* data on 1997 housing construction, over 1.5 million garage doors were installed in new housing units. Approximately 600,000 of these doors were insulated steel doors. With conservative assumptions, the combined area of these insulated doors is an estimated 33 million square feet.

Rectangular Duct Insulation

Description of Application

HVAC ductwork is often located in attics and unconditioned crawlspaces and basements. When ducts are installed in unconditioned portions of the building envelope, they must be insulated. Individual duct runs to supply registers are frequently pre-insulated flexible duct. Main trunk lines are typically rectangular metal ducting. Trunk lines are usually insulated with foil-faced fiberglass insulation wrapped around the duct and fastened with foil tape. The R-value of this duct insulation is approximately 7.

Vacuum insulated panels could be used to provide insulation on the rectangular main trunk line. Panels could be attached with foil tape in the same manner as the fiberglass insulation.

Benefits

Little or no modification to the manufacturing process would seem to be needed to produce VIPs for use as duct insulation. Panels could be produced in standard sizes and lengths to accommodate common duct sizes. VIPs could provide a significant increase in R-value over current duct insulation and could account for a significant increase in the performance of the house. The risk of damage by consumers after construction should be minimal because ductwork is rarely altered or disturbed by occupants.

Limitations

Perhaps the most significant limitation associated with the use of VIPs as duct insulation is the potential small size of the VIPs needed. The small size of the VIPs would mean that the impact of both thermal shunting and seam leakage would be high. Also, there would be a large risk of damage during construction. Some penetrations in the barrier film are inevitable, because cutouts must be made for branch ducts. The necessity for installers to work extra carefully with this material would most likely slow them and result in increased insulation costs. Penetrations in VIPs could be minimized with the use of smaller individual panels, but this would most likely result in increased installation time and costs.

HVAC ductwork is subject to relatively high temperatures, near the threshold for VIPs, and also rapidly fluctuating temperatures. Both of these factors could contribute to the premature degradation of the barrier film and vacuum.

Potential Market Size

Approximately 94 percent of new houses in 1997 had ducts, and almost 51 percent were metal. The average length of ducting in those houses was estimated to be 32 feet.

Almost half of all new single-family houses are estimated to have main ducting located in non-conditioned spaces. The houses accounted for about 9 million feet of metal main ducting. Main ducting averaged 32 feet in length, and about one-half of it was metal.

Assuming that the ducts measure 8" x 18", every foot of duct would require almost 4.5 square feet of material. This means that the 9 million feet translates into about 40 million square feet of surface available for insulation.

Retrofit Exterior Insulation

Description of the Application

Re-siding projects using maintenance-free siding materials, such as vinyl or aluminum, often include the installation of a thin layer of sheathing beneath the siding. The sheathing provides a level surface for attaching the new siding. Frequently, the sheathing is a thin layer of foam insulation board, which not only provides a backing surface, but also provides an added level of insulation.

VIPs could be used in conjunction with furring strips to provide a much higher level of insulation for such applications. The application considered here involves the use of vertical foam or wood furring strips for the attachment of the siding material. VIPs could be installed between these furring strips to reduce the risk of damage to the barrier film.

Benefits

The application would allow the use of panels of standardized height and width, while panel thickness could be varied to provide the level of insulation desired. The incorporation of VIPs in siding retrofit work could substantially improve the thermal performance of existing homes and could provide a useful method for adding insulation to homes that do not contain necessary insulation levels. Although the life span of the material is important, it is not as important as with new construction and applications located within building cavities.

Limitations

The most significant drawback to the use of the VIPs for this application is the risk of damage to the barrier film during construction. Trade contractors would have to be trained to install the material properly without damaging the barrier film. Because of the extra care required in the installation of materials and the need for installing furring strips, the cost of installing the VIPs in this situation could be significantly higher when compared with other insulation materials. Occupants would also have to be notified of the risk of damage to the barrier film that could occur if they install ornamental fixtures or accessories to their homes.

Potential Market Size

About 65 million square feet of foam insulation was installed on exterior walls in 1997, but the ultimate market potential for this VIP application may be larger. VIPs might be considered substitutable for other sheathing materials in certain situations. Of course, not all siding-retrofit projects can easily accommodate the use of VIPs. Projects that entail the installation of vinyl, aluminum, brick, hardboard, OSB, lumber/boards, steel or fiber-cement siding products seem the most likely candidates. Analysis of the data indicates that the materials mentioned above comprised almost 83 percent of the approximately three billion square feet of siding purchased for retrofit projects in 1997. Considered together, they account for over 2.3 billion square feet of material.

Another factor that could affect the likelihood of including insulation in a siding retrofit job is the age of the house. Older houses are more likely to benefit from a significant increase in the level of insulation. In particular, houses built before the 1970s are likely to be less heavily insulated. According to the 1997 repair and remodeling data, over 56 percent of the siding retrofit jobs were on houses built before 1971. If we assume that siding types were installed uniformly across all house age categories, then an estimated 56 percent of 2.3 billion square feet of the appropriate type of siding was installed on houses that are more likely to benefit from higher R-values offered by VIPs.

Acoustic Ceiling Panels

Description of the Application

Acoustic ceiling tiles are square or rectangular shaped ceiling panels held in place by a metal framework suspended below the actual ceiling. The tiles are made of fiberglass, mineral fiber or other materials and serve multiple purposes. First, they conceal utilities running beneath the actual ceiling, while allowing easy access to wiring and plumbing for maintenance and repair. They also dampen sound and thus enhance the acoustical performance of a room. In the residential sector, they are frequently used in remodeling projects to convert an unfinished basement into a finished living space.

VIPs could be laminated to the back of the ceiling tiles so that installers could thermally isolate the living space below the tiles from the space above while at the same time providing an attractive ceiling. The panels could be used to provide either some or all of building's ceiling/attic insulation.

Acoustic tile ceilings suspended below flat roofs of light commercial buildings are sometimes insulated. Major insulation manufacturers currently market insulation products for use with these suspended ceilings.

Benefits

The process of installing the tiles does not appear to hold any major hazards. Likewise, since ceiling panels are suspended out of the way of traffic and are not frequently disturbed, little danger of violating the integrity of the vacuum is anticipated after installation. Finally, since the panels are easily replaced, limitations on the life span of the peak insulation value of the panels may not be a major issue.

Integrating the VIP into the ceiling tile will provide users with a single-component system. Installation and subsequent access to utilities may be greatly simplified compared to other suspended-ceiling insulation systems where the tile and insulation remain separate components.

Limitations

Integration of VIPs into acoustic tile for use in a typical residential application does not seem to promise much potential for impacting residential thermal performance. For example, a typical

basement-remodeling project might entail using ceiling tiles to conceal wiring and plumbing, so that the ceiling has a finished appearance. At the same time, the basement walls would need to be insulated if none was already in place prior to the installation of gypsum board. Given this situation, it does not make sense to insulate the basement ceiling with VIPs so that the space is thermally isolated from the rest of the house. It should also be noted that it is not likely that many unfinished basements would be fitted with acoustic tile ceilings.

Potential Market Size

Ceiling tiles of all types account for about one percent of ceiling finish material used in new residential units. In residential retrofit repair and remodeling activity, they account for about seven percent of ceiling finish materials. As discussed above, it is not likely that these tiles are commonly installed with insulation.

Insulation is installed above acoustic tiles in the commercial sector. At least two of the major insulation manufacturers market insulation products designed to be used with ceiling tiles. The interest of major insulation manufacturers in this system would seem to indicate a potentially large market for an insulated suspended-ceiling system.

Information on the magnitude of annual commercial construction is normally published in terms of the "value of construction put in place", so data on the number of buildings constructed annually is not normally available. One source of data that is periodically available is the U.S. Department of Energy's *Commercial Building Energy Consumption Survey*. According to this source, there were approximately 4.6 million commercial buildings in the United States as of 1995. During the period 1990 through 1995, 420,000 commercial buildings were constructed. More detailed information on the scope of the commercial market was not pursued.

Attic Access Panels/Stairway Insulation

Description of Application

Building codes require that residential attics be accessible through either a drop-in panel or pull-down stairs. These attic access panels are notoriously difficult areas to insulate. Typically, builders will attach a piece of fiberglass batt insulation to a piece of gypsum board to serve as the access panel. However, this insulation is frequently either removed or damaged by homeowners in attempting to make the panels easier to move. As a result, insulation fibers cascade down onto the homeowner or carpet. Pull-down stairs, in contrast, are typically not insulated or are poorly insulated.

VIPs could be used to accommodate the insulation needs for both attic access panels and stairways. A protected VIP could be adhered to the gypsum board in lieu of fiberglass insulation. VIPs could be incorporated into the support board for the pull-down stairs.

Benefits

VIPs could be incorporated into attic access panels and stairways using their current manufacturing processes. The importance of concerns regarding the potential life span of the VIPs was deemed minimal for this application. If homeowners desire, the access VIP panel can be replaced. Even if it were not replaced, the R-value of the core material (R-4) would be more than if a fiberglass batt was removed and not replaced.

Adhering the VIP to the gypsum board panel would be no more difficult that attaching a fiberglass batt. Likewise, incorporation of VIPs should not alter the installation procedure for pull-down stairs. Thus, there should be little or no added installation cost and little risk of damage of the product during construction. Given that a protective layer is adhered to the VIP, there should also be little risk of damage by consumers after construction.

Limitations

Few significant limitations with the use of VIPs in this application were noted. The only drawback is the limited impact of this application on energy efficiency. While the VIPs would have a substantial impact on the thermal performance of the attic access panel/stairway, the change in the overall performance of the home would likely be minimal due to the small size of access panels.

Potential Market Size

Considering the 1 million plus single-family starts in recent years, and the large stock of existing homes, the potential market for this application is very large. Virtually every detached and attached single-family house has an attic. Even the finished attics in Cape-Cod-style houses use vertical access panels.

APPENDIX C

REMODELER'S AND CUSTOM BUILDER'S FOCUS GROUP SUMMARY

INTRODUCTION

Background

The NAHB Research Center (Research Center) and DOW Chemical Company with support from the PATH program are conducting a program to accelerate the development of products for the home construction, renovation, and remodeling industries that take advantage of the energy-conserving benefits of vacuum insulation technology. Three major areas have been identified as potential uses for this technology in residential applications: as insulation for exterior entry doors, insulation for exterior garage doors, and insulation for attic access panels. As a follow-up, the Research Center conducted focus groups to test the viability of this technology in these applications among builders and remodelers.

Purpose

To determine the perceptions, opinions, and attitudes of builders and remodelers toward vacuum insulated panels (VIPs) in various residential uses.

Methodology

Two focus groups were conducted using standard methods by the NAHB Research Center, Inc. The groups were held at the Philadelphia Marriott on November 5 and 6, 1999. They were audio and videotaped and viewed via closed-circuit television by Research Center, DOW, and PATH representatives. Both groups were moderated by Karen M. Johnson.

Respondent Characteristics

Focus group respondents consisted of residential remodelers and builders from cold and moderate climates in the United States. Respondents consisted of owners, presidents, production managers, and supervisors with experience in the installation, specification, and purchase of building products, including exterior entry doors, garage doors, and attic access panels for their homes.

CURRENT PRACTICES

Exterior Entry Doors

Type. Both groups included a mix of fiberglass, steel, and wood door users, and almost all respondents used more than one type of door. Respondents stated that selection of door type is usually dependent on the market segment and overall cost of the home—steel doors are usually used in starter and first-time move-up homes, fiberglass doors are used for move-up homes, and most wood doors are used in custom/luxury homes. Additionally, steel and fiberglass doors are

frequently used for other entry doors in higher-end homes, and steel doors are often used for garage entry doors because they are fire-rated.

Although respondents agreed that consumers often prefer wood doors for their aesthetics and weight, most remodelers associate them with performance problems, such as cracking, warping, splitting, high maintenance, and poor insulation. Additionally, they are usually higher in cost and more difficult to install. Steel was considered an inexpensive, durable, but also unattractive option. Several respondents considered fiberglass a compromise between wood and steel because it is priced between wood and steel, is often more attractive than steel and more durable than wood, but does not have the feel of real wood or the strength of steel.

Insulation. Respondents stated that fiberglass and steel doors are constructed with a foam core that insulates them. Most did not perceive a great difference between the insulating properties of fiberglass and steel, but considered wood to have a significantly lower R-value than other door types.

However, most respondents agreed that insulation of exterior entry door panels is not an issue with them. They were unaware of insulation differences among brands, and uninterested in determining the R-value of doors. Although the exterior doors are often a weak point where energy losses occur, respondents stated that this results from drafts around the sealing of the door or through windowpanes, not through the door panel itself. Additionally, consumers have little influence—they are often only concerned with the appearance of the door, not with its insulating properties. In fact, they may prefer to have an uninsulated door for aesthetic reasons. Door insulation is usually only an issue if the remodeler must meet energy requirements.

Sample statements from participants include:

"None of my customers talk about the insulation factor of the doors – it's always appearance, and how long will it last, will it stay together, will [it] stain okay? But no one is asking me to say, what's wood relative to an insulated door?"

"I think it is [an issue] with us more than it is with the customer…we're protecting ourselves. …On some projects, we might have to issue an energy statement to the building inspector regarding the type of construction, if it's a large addition or if it's a new home, and …we're supposed to meet those standards. The customer might not pay much attention to that, but we do and that affects the product that we might use for windows and doors."

"There's a lot of energy loss because it's just a single pane of glass. And if you go on the insulated, a lot of times we get complaints that the mutton bars are too wide. So then you've got to try to talk them into an energy panel on the outside to

help improve the energy loss…If you're in an historic district, they don't want to see energy panels. …They'd rather …lose the heat out the door than put an energy panel on."

Garage Doors

Types. Most respondents used steel garage doors, because they have few or no callbacks and are paintable. Some also use vinyl garage doors, but stated that they are not paintable. None of the respondents currently use wood doors, which are now only available through special orders and have the same performance issues as wood exterior entry doors. They also cost substantially more than other doors.

Insulation. Almost all respondents stated that they used insulated garage doors. Most considered using insulated garage doors an easy choice—the insulated garage doors are better insulated against energy losses and sound, are more rigid, and cost little or nothing more than non-insulated doors. As with exterior entry doors, remodelers may have to use insulated garage doors to meet energy code requirements. Although respondents agreed that huge energy losses occur through garage doors, most expect these losses and were not concerned about decreasing them.

Sample statements include:

"We use the insulated because it's a little more rigid and the cost is the same as non-insulated."

"And it doesn't make any sense not to use it because it does add a little more, again, dimensional stability to that product at little or no extra cost, so why not?"

"*[The garage is] the weakest point in the whole house pretty much."*

"It absorbs the sound better…Street noise."

Weight. Although some respondents felt that lightweight garage doors may be easier to install, most did not consider weight an issue or see an advantage to using a lighter weight garage door.

Attic Access Panels

Respondents stated that attic access panels and pull-down stairs are a problem area—they agreed that great energy losses often occur through uninsulated panels, and that these panels are often poor in quality. Although ceilings are well insulated to reduce energy loss, attic access panels and pull-down stairs are never insulated themselves, obliging remodelers to apply makeshift solutions, such as

stapling rigid foam insulation to the panel or building insulating domes over the panel.

Sample statements include:

"It's a joke to try and get these things to fit tight."

"We make up a Styrofoam box. We take some rigid Styrofoam insulation, typically 2 inches, sometimes more if we can get it, and we basically build what looks like a sandbox and then we turn it upside down and we place it in the attic right over the stairs. So you pull the stairs down to go up into the attic and you've got this little lightweight Styrofoam box, you flip it aside, you go up and you come back down and put the box back over the opening again and then close the stairs up. It works slick and it costs you about $15, if that."

"We usually use rigid foam. We do a couple layers. We will screw it and I use a thicker piece of plywood …then we'll weather strip the edge of the opening."

DECISION MAKING AND PURCHASE CRITERIA

Switching

Reluctance. Most respondents stated that they were reluctant to switch to a new product unless they are unhappy with their current product or feel there is a financial incentive to switch. They are also unlikely to use products that are new in the market—most prefer to "wait and see" how products will perform before taking a chance on it themselves.

New Products. Despite their reluctance, respondents like to be made aware of new products. Most learn about new products through trade publications and conventions.

Switching Process. Respondents stated that when they are considering switching to a new product, they usually research it first, through their suppliers and the Internet. Most prefer to "experiment" with the product first by using it on a limited basis or in their own homes.

Important Attributes

Respondents were asked to rate several different attributes as very important, somewhat important, irrelevant, somewhat unimportant, and not important to their purchasing process when selecting a new product (see Table 1).

Table 1. Important Attributes

	Very Important	Somewhat Important	Irrelevant	Somewhat unimportant	Not important
1. R value					
2. Thickness					
3. Availability					
4. Building Code Acceptance					
5. Certified Installers					
6. Consumer Recognition					
7. Ease of Installation					
8. Engineering/ Laboratory Certification					
9. Environmental Friendliness					
10. Peer Usage					
11. Manufacturer Support					
12. Warranty					

Few respondents Some respondents Most respondents

The most important attributes identified by participants were:

Availability. Before using a new product, remodelers stated that the product would have to be readily available in their area. They want to know that they will be able to use the product when they want it.

Building code acceptance. For many builders, building code acceptance is a consideration for all new products.

Ease of installation. Respondents agreed that difficult installation results in time and money lost for them, especially considering the current labor shortages.

Manufacturer support / Warranty. Remodelers are reluctant to try new products because they are weary of introducing new problems. If they are familiar with the manufacturer and feel they can count on the manufacturer's support if there is a problem, they are more likely to use a new product. The same is true if there is ample warranty provided.

REACTIONS TO VIP TECHNOLOGY

Respondents were first shown small samples of the vacuum insulated panels. The panels were described as lightweight, with a vacuum-sealed foam that prevents heat from transferring through the panel, and an R-value that is five to six times higher for the thickness than other types of insulation (R-30 for one inch insulation). Respondents were then shown examples of the panels used in an exterior entry door, a garage door, and an attic access panel.

R-Value. Respondents immediately reacted to the R-value of the panels. The considered R-30 per inch to be an impressive R-value, but many were also skeptical. Some stated that they had been deceived about R-values in the past. They alluded to windows that claimed a high R-value—a claim that was based on a small portion of the pane rather than the entire window unit, which had a substantially lower R-value.

Remodelers were initially impressed by the R-value of the panels, but were also subsequently suspicious of it. They compared it to radiant barriers because of the foil wrapping.

Initial Reactions. Before being given possible applications (e.g., doors and attic access panels), respondents assumed that it would be used for wall insulation, but were concerned that it would be too easily broken during installation. They suggested potentially using it to back siding—this would be advantageous because it is thin and lightweight, allowing for easier installation and smooth lines.

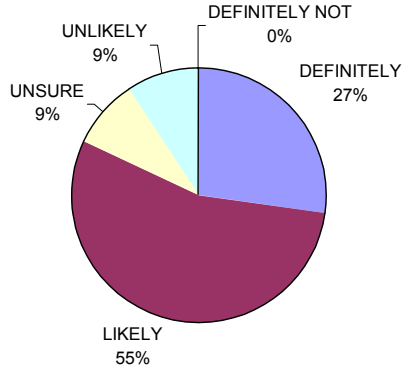
Exterior Entry Doors. Remodelers had a number of concerns about using the VIP technology in doors. Primarily, they stated that improving the R-value of the door would not make the door more valuable. Because most energy losses occur around the seal of the door, respondents stated that a better-insulated door would not improve the value of the entire unit.

Garage Doors. As with exterior entry doors, respondents did not see a clear advantage to using VIP technology in garage doors. Almost all respondents were currently using insulated doors, at little or no extra cost. Additionally, many were concerned about the sound-insulating properties of the panels, an important consideration for garage doors.

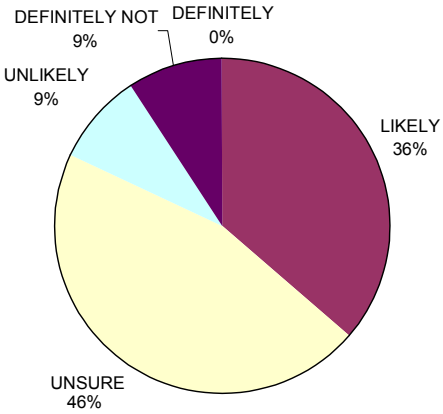
Attic Access Panels. Respondents were very enthusiastic about using VIP technology for attic access panels. Although they were still unlikely to try the product if it increases cost, they thought it would provide a better way to insulate a problem area that currently has no solution.

Cost. Respondents were generally concerned with how much the panels would increase the cost of products. Some respondents stated that they would try the technology if it were comparable in cost to their current products. For example, the following pie charts illustrate the cost-sensitivity of respondents to VIPs in door assemblies.

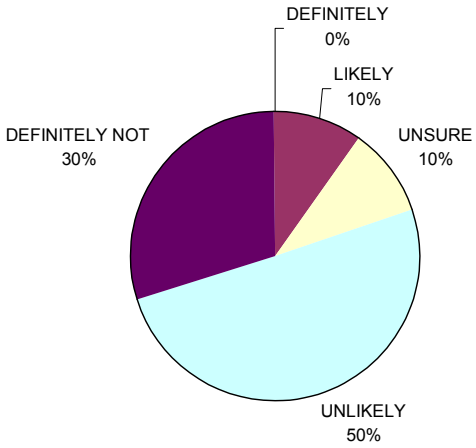
Willingness to purchase VIP Insulated Door at SAME PRICE as Current Door



Willingness to Pay $50 More for VIP Insulated Door than Current Door



Willingness to Pay $100 for VIP Insulated Door than Current Door



APPENDIX D

DO-IT-YOURSELFER'S AND CARPENTRY CONTRACTOR'S FOCUS GROUP SUMMARY

INTRODUCTION

Background

The NAHB Research Center (Research Center) and the DOW Chemical Company, with support from the PATH program, are conducting a program to accelerate the development of products for the home construction, renovation, and remodeling industries that take advantage of the energy-conserving benefits of vacuum insulation technology. Insulation for attic access panels and pull-down stairs was identified as a potential residential use for this technology. As a follow-up, the Research Center conducted focus groups to test the viability of this application among framing contractors and Do-It-Yourselfers (DIYs).

Purpose

To determine the perceptions, opinions, and attitudes of contractors and DIYs toward using vacuum insulated panels (VIPs) in attic access and pull-down stair panel applications.

Methodology

Two focus groups were conducted using standard methods by the NAHB Research Center, Inc. Both sessions were held at the NAHB Research Center in Upper Marlboro, Maryland on March 21, 2000. They were audio and videotaped and viewed via closed-circuit television by Research Center staff. Karen M. Johnson moderated both groups.

Respondent Characteristics

Respondents consisted of contractors and DIYs from the Washington, D.C. and Baltimore area. Contractors were experienced with residential framing techniques, including attic access panel and drop-down stair panel installation, and insulation installation. Several also had remodeling experience. DIYs were experienced with general home improvement projects, including insulation installation.

USAGE

Attic Access versus Pull-Down Stair Panels

Almost all contractors stated that they were using both attic access panels and pull-down stairs. Most offer pull-down stairs as an upgrade to attic access panels. Unlike attic access panels, which most contractors construct from surplus construction materials, pull-down stair panels are purchased as prefabricated units from big-box stores, such as Home Depot or Lowe's.

The majority of DIY respondents lived in homes with attic access panels only. Only one participant currently had a pull-down stair panel, which replaced an original attic access panel. Although most agreed that the pull-down stair panels were more convenient than attic access panels, installing them was considered a low priority because most did not use their attics frequently. Although some agreed that they would probably use attics more regularly if they were easily accessible, most did not feel that this warranted installation of new panels.

COST

Attic Access Panels. Contractors stated that the cost of attic access panels was minimal (under $10) in new construction—the panels are constructed from surplus construction materials and the cost is included in the overall framing costs. However, for retrofit applications, the cost is higher - contractors may have to purchase the materials specifically for the application and must charge for their time to install. Some contractors stated that higher-end customers might be willing to pay substantial amounts to improve the aesthetics of the panel. Consequently, retrofit costs for attic access panel installation can range from $50–500 dollars.

Pull-Down Stair Panels. Participants agreed that pull-down stair units range from $75–125, depending on quality.

INSTALLATION AND INSULATION

Attic Access Panels. Most contractors agreed that installation of attic access panels is a standard aspect of framing. However, because attic access panels are not sold as distinct units, they are makeshift apparatuses that are constructed from surplus framing materials, and as a result, may vary from house to house. Framing techniques (such as trusses) and codes may be the only guidelines provided for installation.

DIYs felt that attic access panels were easy to create or alter because of their simple construction, though few had personally installed or modified them.

Contractors agreed that insulation techniques, although effective and inexpensive, are often sloppy and discourage attic access by homeowners. Panel insulation is also improvised, and may consist of only a piece of insulation (usually batt insulation, depending on what was used to insulate the attic) that is laid over the panel. Although this is effective in insulating the area, the insulation provides an extra hassle for homeowners when entering the attic. Some contractors stated that they construct a dome around the panel to improve insulation, but that this can also be cumbersome for homeowners to handle. Several contractors agreed that

energy losses could occur through attic access panels, especially in homes with frequently accessed panels, where the insulation may have been removed or damaged by the homeowner.

Drop-Down Stair Panels. Contractors and homeowners agreed that drop-down stair panels are typically purchased as a pre-assembled unit and, as a result, are easy to install. None of the respondents had experienced problems with stair panel installation. Several respondents had experience with "upgraded" stair panels, which include stairs that fold or extend more easily.

Contractors stated that drop-down stair panel units are not insulated, and are usually not insulated by them after installation. They explained that insulating stair panels makes them impossible to use because bulky insulation interferes with the working parts of the stair unit. However, they stated that this often conflicts with codes, which require the entire ceiling to be insulated. Some contractors stated that if an inspector demands that the panel be insulated, they place insulation over the panel for the inspection. They acknowledged that this is not a permanent solution. Participants agreed that energy losses occur through these panels because they are not insulated, but most did not feel that insulating them is worth the hassle.

IMPORTANT ATTRIBUTES

Participants for both groups were asked to rate the importance of several attributes for attic access and drop-down stair panels. Generally, DIYs tended to rate all attributes as important, while contractors were more selective in which ones they chose as most important. Exceptions included building code acceptance and appearance, which contractors rated higher than DIYs. (See Attachment 1.)

Building Code Acceptance. This is a constant concern for contractors, especially with drop-down stair panels, which are not insulated. However, for DIYs, building codes are not an issue—most were not aware of them.

Appearance. Contractors considered this an important attribute for many homeowners. One stated that homeowners would pay a great deal to ensure details like attic access panels are attractive and unobtrusive. DIYs, however, were much more concerned with the functionality of the panels and did not place importance on their appearance.

R-Value. DIYs considered the R-value important for both attic access panels and drop-down stairs. However, contractors considered the R-value less important for drop-down stair panels due to the cumbersome installation involved with insulating them.

Manufacturer. Participants in both groups rated manufacturer as one of the lowest attributes. Almost all respondents were unfamiliar with the panel manufacturer they currently use, most were not aware of any panel manufacturers at all.

REACTIONS TO VACUUM INSULATED PANELS

Initial Reactions. Respondents were shown samples of VIPs, and asked for their immediate reactions. Some associated the panels with radiant barrier insulating panels because of the foil casing, but none were familiar with vacuum insulating technology. Several participants commented that the panels seemed lightweight.

Reactions to VIP Technology. Respondents were informed that the panels use vacuums to insulate at high R-values with small thickness. Most responded favorably to the high R-values (approximately R-25-30 per inch). Although some participants distrusted the high R-values, most were interested in the technology and wanted to know more about the panels.

Several assumed that the panels would be used for wall insulation. Most were excited about potentially using VIPs for this application because they felt the panels would be lighter, neater, and have high R-values, than current wall insulation. However, this discussion quickly lead to questions about durability, including its ability to withstand nailing, stapling, and other damage that may occur during construction. Many also wondered how they would be able to seal the product.

REACTIONS TO VIPS IN ATTIC PANEL APPLICATIONS

Respondents were shown a sample VIP attic access panel. The sample was constructed of a VIP encased between two polystyrene panels reinforced with mesh on their exterior. Participants were asked for their reactions to using VIP technology with attic access panels and drop-down stair panels.

Initially, most respondents had positive reactions to using VIPs for these applications, though reactions were more enthusiastic toward their use in drop-down stair panels than in attic access panels. Additionally, contractors were more enthusiastic than DIYs about the technology in general.

Benefits. Several contractors agreed that VIPs were "something we've been looking for" for drop-down stair panels. They explained that although drop-down stairs are currently not insulated, VIP panels might provide them with a cleaner, less obtrusive alternative. Some respondents felt that VIPs are a salable product because of their high-R-values and low weight. They also felt that its environmental-friendliness would be appealing to homeowners.

CONCERNS

Cost. Despite their positive reactions to the benefits of the VIPs, most respondents assumed that the product would cost significantly more than current panels and that this

may be a deterring factor for them. Participants' likelihood for purchase decreased significantly as the cost of the panels increased. (See Attachment 2.)

This was especially true for attic access panels, because most contractors considered current panels acceptable and extremely inexpensive. They also felt that VIP attic access panels would not decrease energy losses because they do not prevent air infiltration around the perimeter of the panel.

Conversely, participants were more likely to pay more for VIP drop-down stair panels. Because drop-down stair panels currently have higher costs than attic panels, additional costs would not be as significant, and would also be absorbed by the homeowner. Although VIP drop-down stair panels would not prevent energy losses around the edge of the panel, they would still be an improvement over current stair panels, which have no insulation.

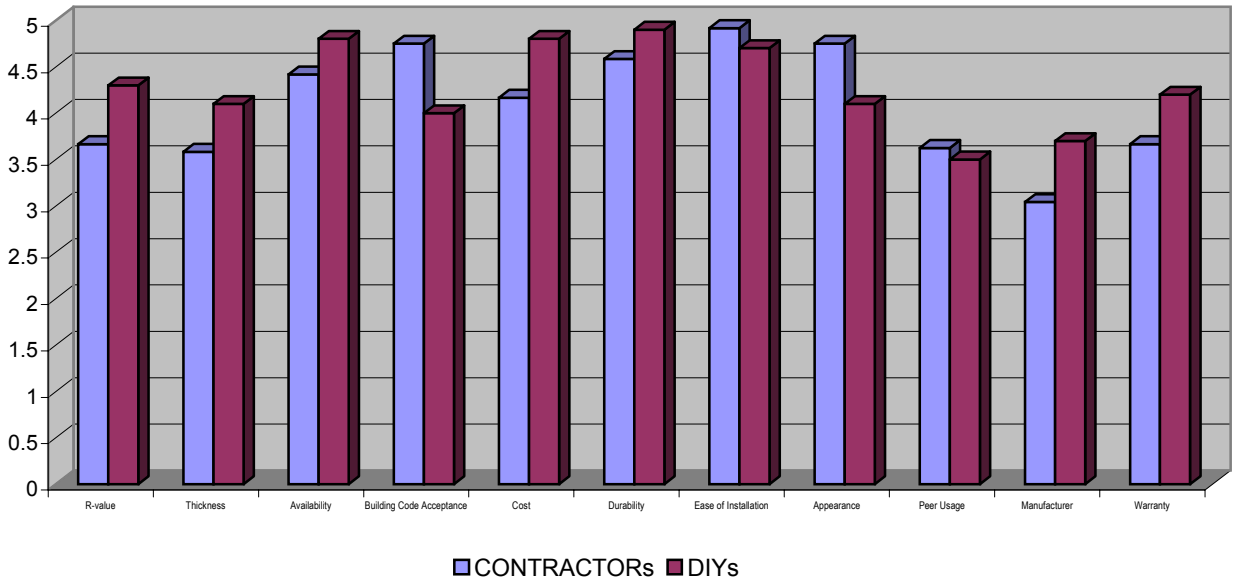
Weight. Although respondents reacted positively to the light weight of the panel samples, they did not have similar reactions to the attic access panel, which many felt was too heavy. Although most grasped the importance of covering the panel, and although several liked the mesh cover, most felt that the heavy encasement would not allow them to take advantage of the VIP's light weight.

Effectiveness. Several participants were concerned about the overall insulating effectiveness of the panel. They wanted to be assured that the panel would not lose its effectiveness over time and that it would not be damaged, even with rough treatment during installation or frequent homeowner usage.

ATTACHMENT 1
TO
APPENDIX D

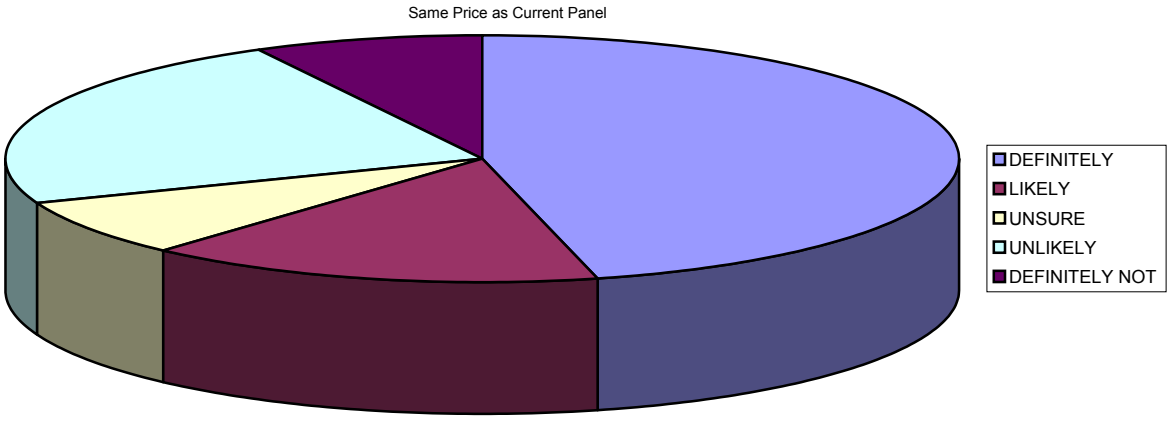
Attic Access Panels' Important Attributes

Drop-Down Stairs' Important Attributes



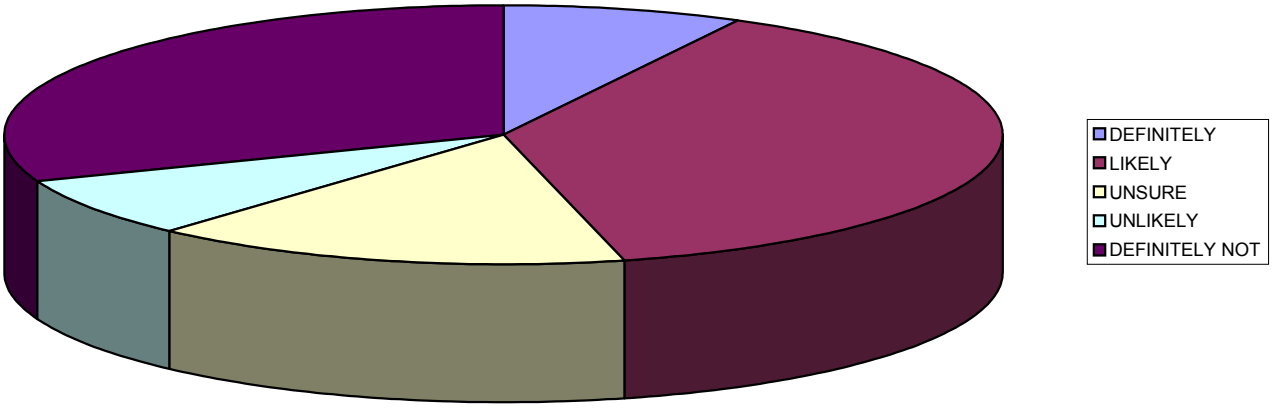
ATTACHMENT 2
TO
APPENDIX D

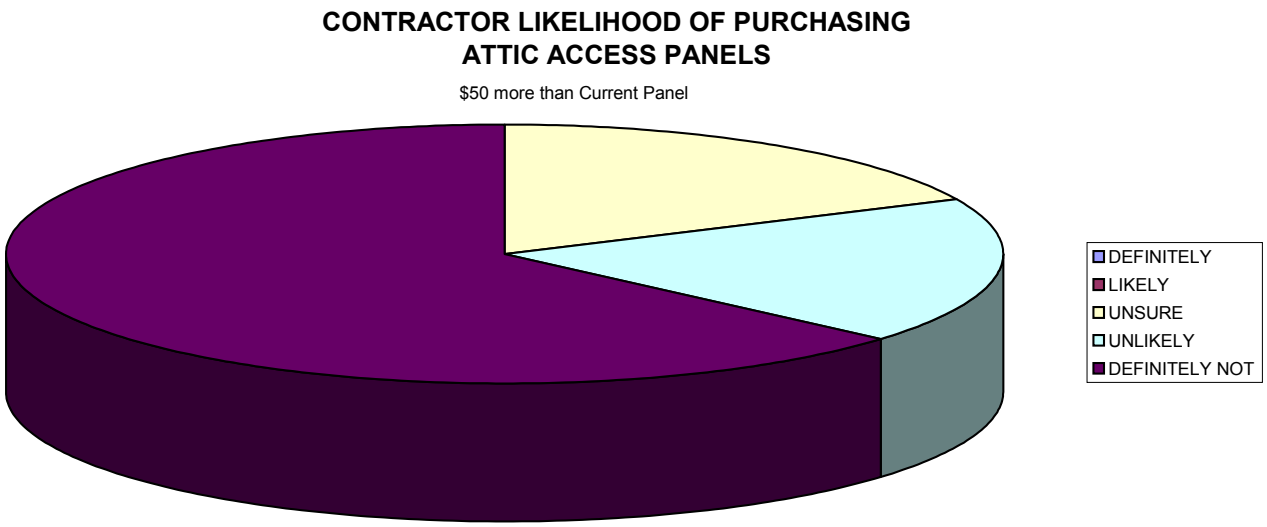
CONTRACTOR LIKELIHOOD OF PURCHASING ATTIC ACCESS PANELS



CONTRACTOR LIKELIHOOD OF PURCHASING ATTIC ACCESS PANELS

$30 More than Current Panel




CONTRACTOR LIKELIHOOD OF PURCHASING
ATTIC ACCESS PANELS
$50 more than Current Panel
DEFINITELY
LIKELY
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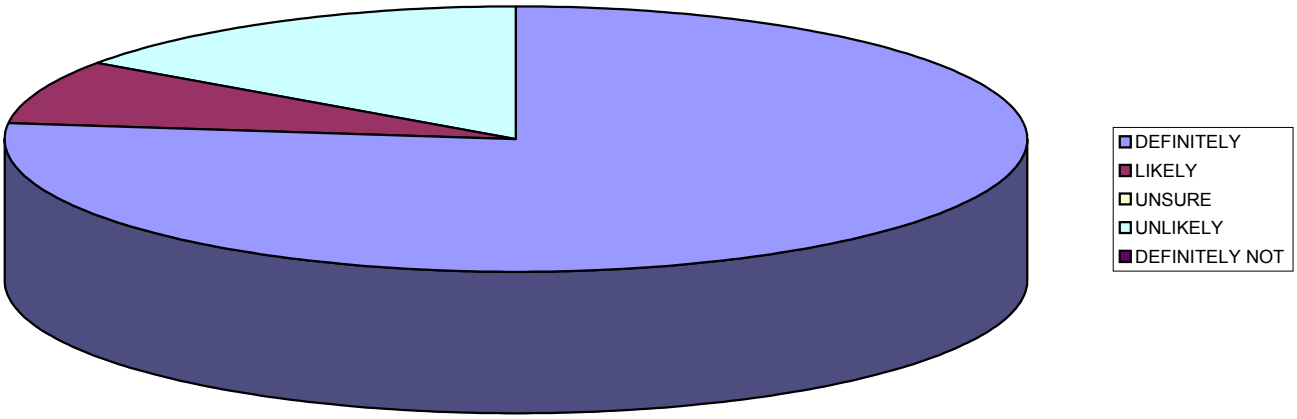
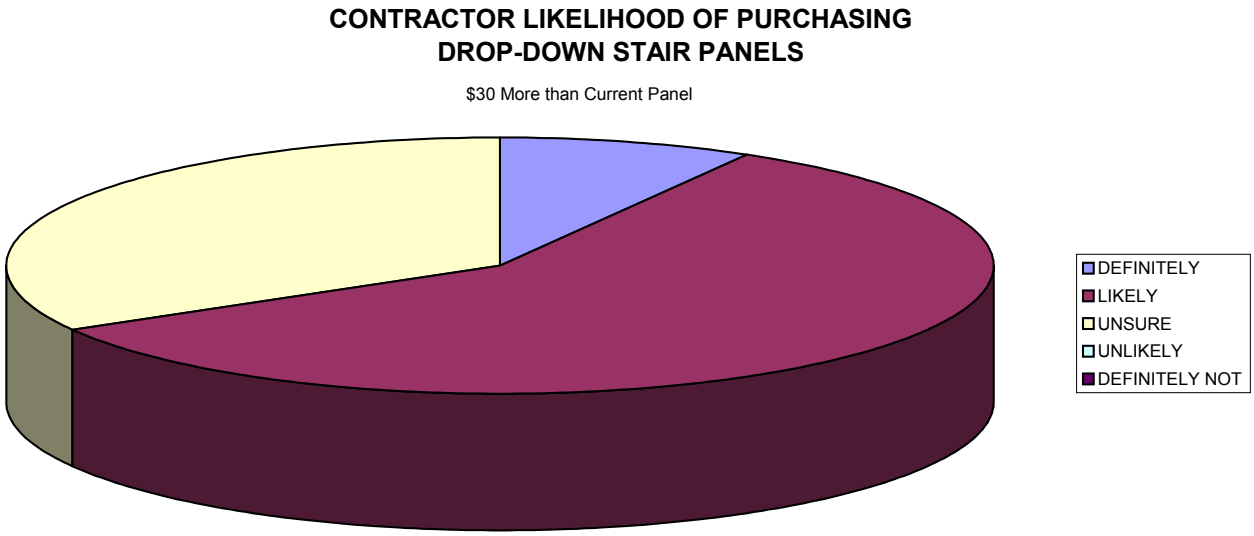
CONTRACTOR LIKELIHOOD OF PURCHASING
DROP-DOWN STAIR PANELS
Same Price as Current Panel




CONTRACTOR LIKELIHOOD OF PURCHASING
DROP-DOWN STAIR PANELS
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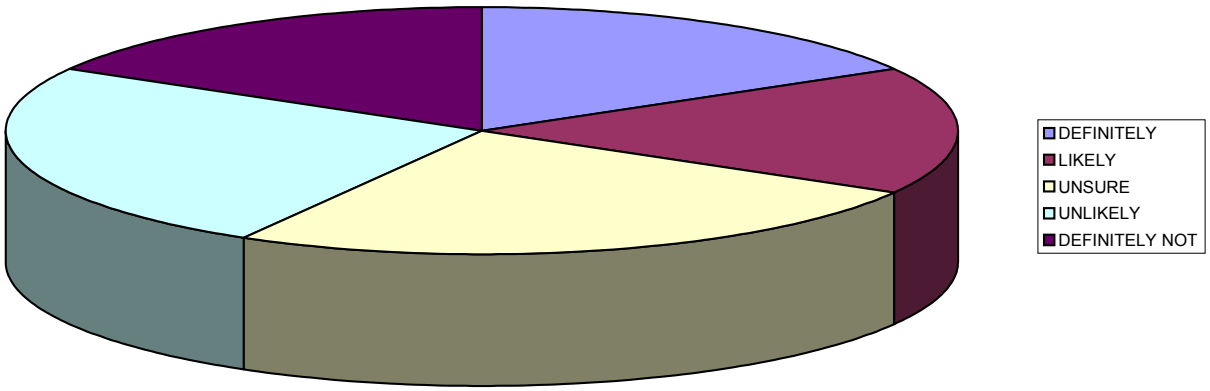
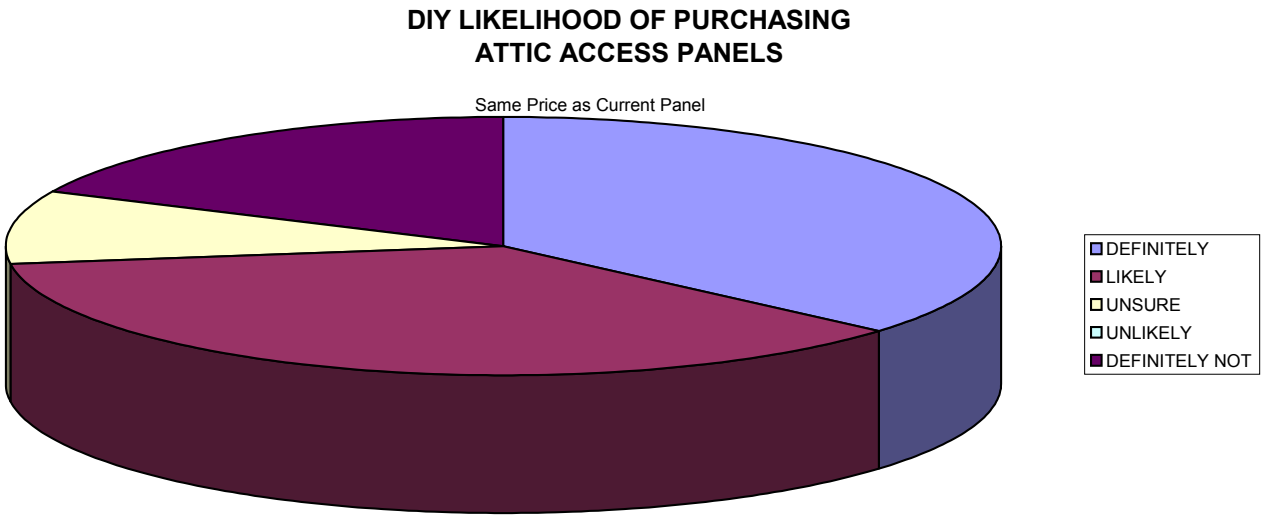
CONTRACTOR LIKELIHOOD OF PURCHASING
DROP-DOWN STAIR PANELS

$50 more than Current Panel




DIY LIKELIHOOD OF PURCHASING
ATTIC ACCESS PANELS
Same Price as Current Panel
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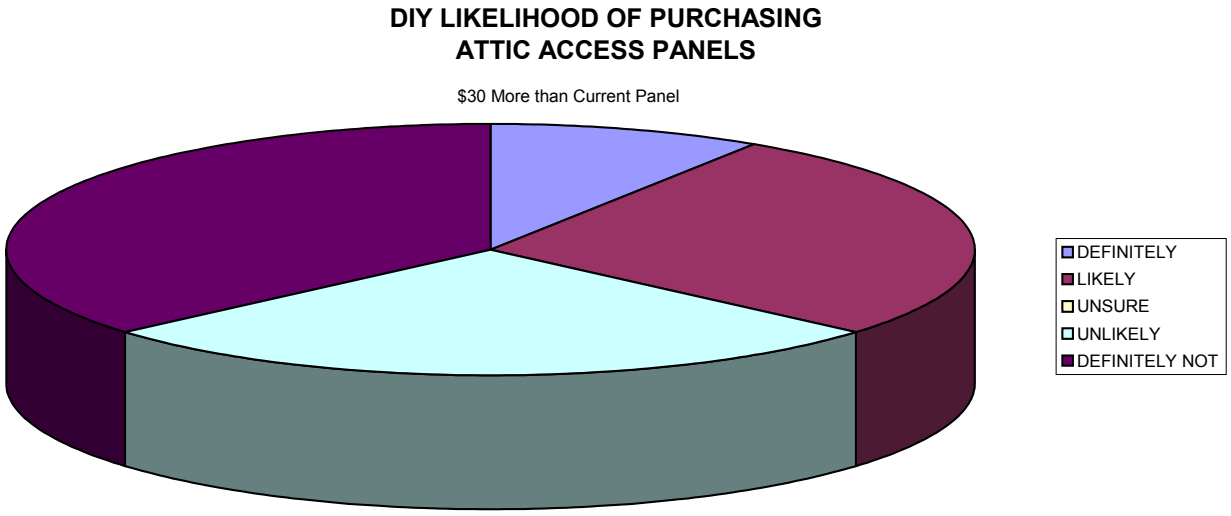
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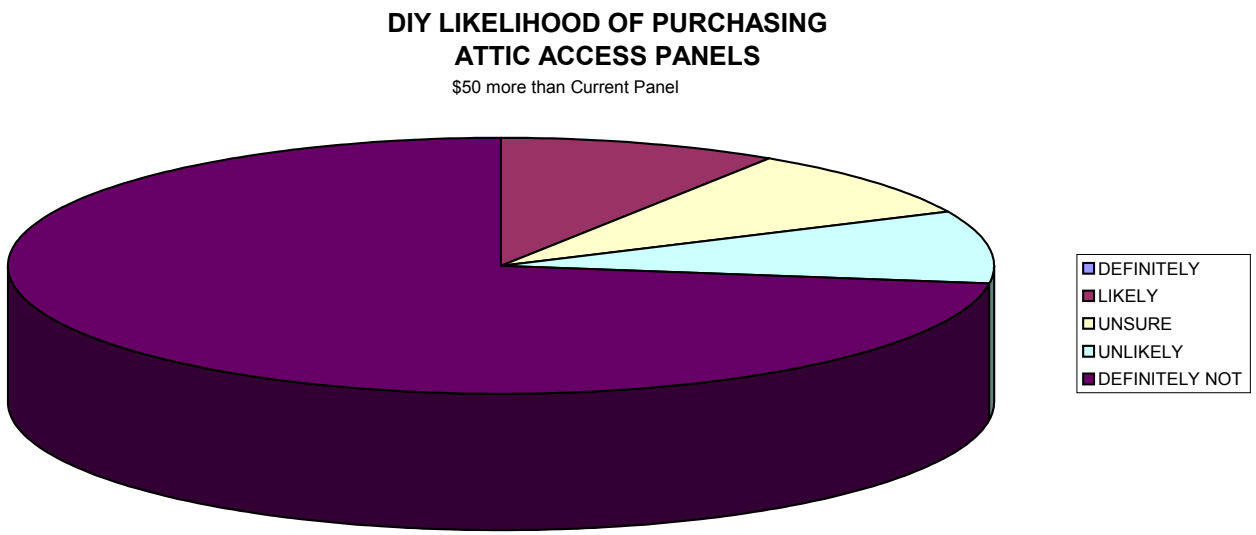
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$50 more than Current Panel
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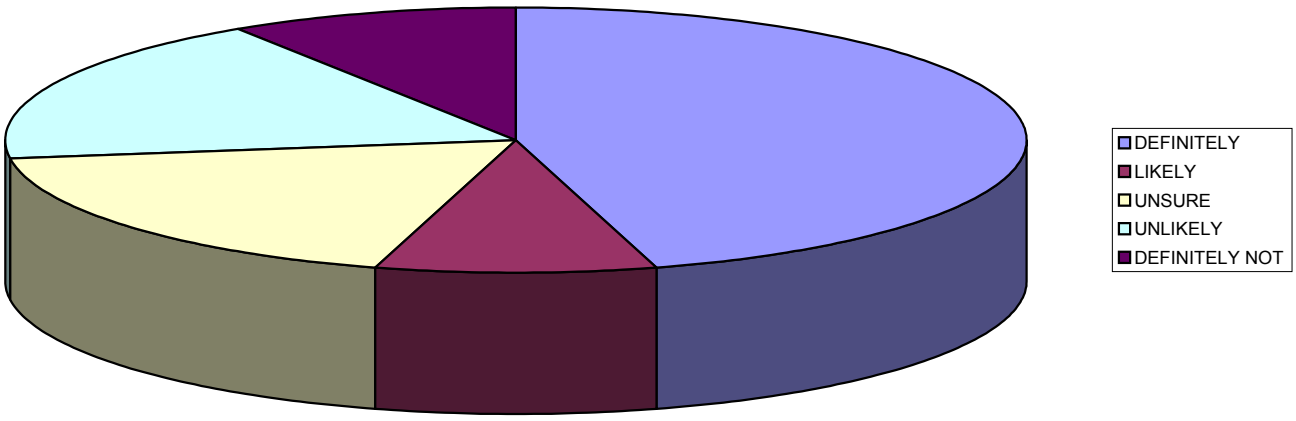
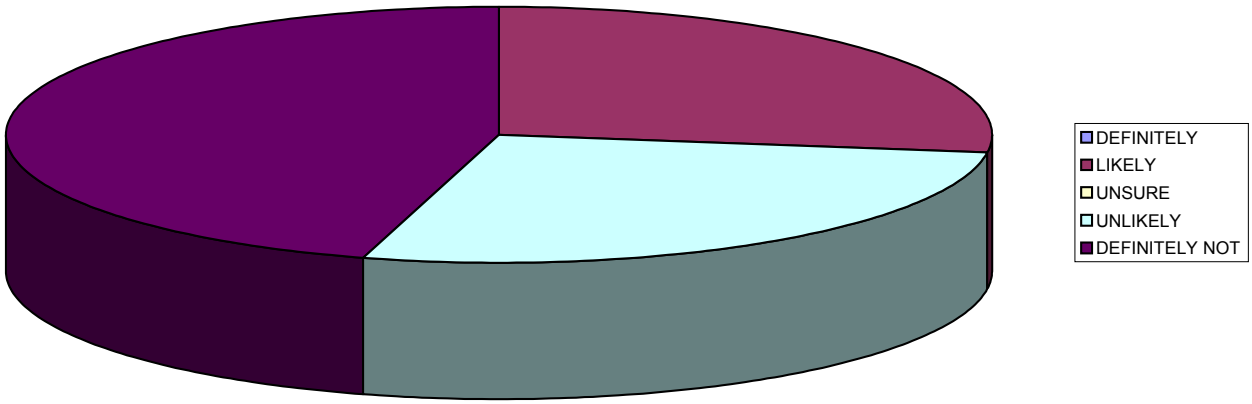
DIY LIKELIHOOD OF PURCHASING
DROP-DOWN STAIR PANELS
Same Price as Current Panel



DIY LIKELIHOOD OF PURCHASING
DROP-DOWN STAIR PANELS

$30 More than Current Panel



APPENDIX E

FIRST DOW INSTILL VIP HATCH NES LETTER OF ANALYSIS

National Evaluation Service, Inc.

5203 Leesburg Pike, Suite 600, Falls Church, Virginia 22041-3401
Phone: (703) 931-2187 Fax: (703) 931-6505

April 26, 2001

Mr. Kevin Weir
Global Marketing Manager
Fabricated Products Department
The Dow Chemical Company
200 Larkin Center
1605 Joseph Drive
Midland, MI 48674

Dear Kevin:

I am writing to inform you of our preliminary evaluation of your submittal and to outline the code issues related to your proposed technology. Based on the information you provided, our technical staff offered the following comments:

Subject: Dow Insulated Attic Access Panels

I. Technology Description

The Dow Insulated Attic Access Panel is an attic access panel that utilizes a vacuum insulated panel (VIP) as its primary component. The core of the VIP is an open-cell polystyrene material. The core is enclosed in a metal foil sheath, a vacuum is applied, and the foil envelope is sealed. To complete the construction of the panel, a sheet of gypsum wallboard is attached to the ceiling side of the VIP and the topside and edges are encapsulated in a sheet of chair cushion-type foam to provide an airtight fit along the edges.

II. General

Test reports must be prepared by an independent testing laboratory acceptable to the NES.

Technical specifications will be needed on all component materials.

Copies of the manufacturer's descriptive literature and installation instructions will be needed.

III. Code Areas of Concern

A. Attic Access Opening Requirements:

Section 1208 of the *International Building Code* (IBC) requires a minimum attic access opening of 20" x 30". The *BOCA/National Building Code* (Section 1211.2) and the *Uniform Building Code* (Section 1505) require a minimum opening of 22" x 30". Section 2309.6 the *Standard Building Code* (SBC) requires a minimum opening size of 22" x 36". The *International Residential Code* requires a minimum 22" x 30" rough-framed opening and the *International One and Two Family Dwelling Code* requires a minimum 22" x 30" framed opening.

Thus, there appears to be a problem with the proposed panel size being able to provide the minimum opening size required for attic access in the model codes. This is particularly true concerning meeting the SBC. Proposed frame and finished opening details for use with the panel would need to be developed and reviewed before we could determine whether the proposed panel size is adequate to meet the other codes.

B. Fire Performance Requirements:

The attic access panel must tested to determine its interior finish classification per Chapter 8 of the IBC since it will be exposed to the interior of the building. At a minimum, this would require finish materials to be tested per ASTM E 84.

The VIP and the chair cushion-type foam used in the panel construction will need to meet the requirements of the code applicable to foam plastic insulation found in Section 2603 if the IBC. Basically this will require an ASTM E 84 test on both the VIP (core material with its metal foil sheath) and the chair cushion-type foam.

Since foam plastics are employed in the panel construction, Section 2603.4 of the IBC will also require the use of a thermal barrier on the ceiling side of the VIP and the use of an ignition barrier over the chair cushion-type foam on the attic side. The proposed construction of the panel does not appear to meet these requirements. Therefore, additional end-use type fire testing may be needed to establish acceptable fire performance or the design of the panel may need to be revised. Some issues of concern are: 1) the proposed 3/8 inch thick gypsum board will not meet code thermal barrier requirements, 2) the ability of the gypsum board to remain in place during a fire needs to be established, 3) there are concerns with the effectiveness of the gypsum wallboard used on the ceiling side of the VIP in protecting the chair cushion-type foam in the proposed use configuration (the chair cushion-type foam covers the edges of the door and may attach to the bottom side of the gypsum board - possibly leaving it subject to direct flame impingement from the underside of the panel and at the joint between the panel and surrounding framing), 4) there is an apparent absence of an ignition barrier on the attic side of the panel, and 5) the construction of the attic access panel to accommodate variations in attic openings could result in varying performance in different opening sizes. Section 2603.7 of the code mentions some end-use type fire tests that might serve as a starting point in determining what type of test might be conducted to address the issue.

If the panel is to be employed on buildings where roof/ceiling assemblies are required to be fire rated for one or more hours, testing per ASTM E 119 will be needed.

The issue of whether the fire performance will change with age will need to be addressed.

C. Thermal Resistance:

Reports of testing to determine the thermal properties of the attic/panel assembly will be needed if the manufacturer wants the evaluation report to include a thermal evaluation. Some suggested test methods include ASTM C 518 for thermal transmission, CGSB 9-GP-15P for thermal conductivity, and ASTM C 236 for thermal resistance. The effects of aging will need to be considered.

The question of whether the VIPs will be manufactured to the size used in the panel or whether

the VIP will be cut from VIPs of larger sizes will need to be clarified. If the VIPs are cut from larger sizes of insulation panels, the effects that cutting to size will have on the thermal performance will need to be determined.

D. Quality Assurance:

Evidence of continuing special inspections of the manufacturer's fabrication process by an NES listed QA Agency will be required. This includes third-party quality control program, containing signed copies of Quality Control/Quality Assurance manual(s), covering quality control procedures, inspection and labeling requirements of the panel fabrication.

Please note that the above information is based on the limited information you have provided to us. Please understand that the minimum requirements to substantiate code compliance may change based on the product composition, profile, scope of our evaluation, and intended use.

Please note that the above information is based on the limited information you have provided to us. Please understand that the minimum requirements to substantiate code compliance may change based on the product composition, profile, scope of our evaluation, and intended use.

We hope the above information is useful to you in further acceptance of your product in the construction industry.

I look forward to hearing from you soon.

Sincerely,

Si Farvardin
Program Manager

APPENDIX F

SECOND DOW INSTILL VIP HATCH NES LETTER OF ANALYSIS

National Evaluation Service, Inc.

5203 Leesburg Pike, Suite 600, Falls Church, Virginia 22041-3401
Phone: (703) 931-2187 Fax: (703) 931-6505

July 30, 2001

I am writing to inform you of our preliminary evaluation of your submittal and to outline the code issues related to your proposed technology. Based on the information you provided, our technical staff offered the following comments:

Subject: VacuPanel Inc. Attic Access Panels

I. Technology Description

The VacuPanel Attic Access Panel is an attic access panel that consists of a polyurethane-encased vacuum insulated panel (VIP) sandwiched between layers of gypsum wallboard. The ceiling-side gypsum wall board measures 24 inches x 24 inches x ½ inch thick while the attic–side gypsum wall board measures 20 inches x 20 inches x 3/8 inch thick. The VIP, measuring 19 ½ inch x 19 ½ inch x 1 inch thick, consists of piece of an open-cell polystyrene core which is enclosed in an evacuated metal foil envelope. The VIP is encapsulated in a layer of polyurethane, foamed in place 1/4 inch deep on all sides.

II. General

Test reports must be prepared by an independent testing laboratory acceptable to the NES.

Technical specifications will be needed on all component materials.

Copies of the manufacturer's descriptive literature and installation instructions will be needed.

III. Code Areas of Concern

A. Attic Access Opening Requirements:

Section 1208 of the *International Building Code* (IBC) requires a minimum attic access opening of 20" x 30". The *BOCA/National Building Code* (Section 1211.2) and the *Uniform Building Code* (Section 1505) require a minimum opening of 22" x 30". Section 2309.6 the *Standard Building Code* (SBC) requires a minimum opening size of 22" x 36". The *International Residential Code* requires a minimum 22" x 30" rough-framed opening and the *International One and Two Family Dwelling Code* requires a minimum 22" x 30" framed opening.

Thus, there appears to be a problem with the proposed panel size being able to provide the minimum opening size required for attic access in the model codes. When an applicant applies

for an NER report, we will request proposed frame and finished opening details for use with the panel so we can determine whether any proposed panel size is adequate to meet the other codes.

B. Fire Performance Requirements:

The attic access panel must tested to determine its interior finish classification per Chapter 8 of the IBC since it will be exposed to the interior of the building. At a minimum, this would require finish materials to be tested per ASTM E 84.

The VIP and the polyurethane foam that encapsulates the VIP will need to meet the requirements of the code applicable to foam plastic insulation found in Section 2603 if the IBC (these requirements are the same as those contained in the *BOCA/National Building Code*, the *Standard Building Code*, the *Uniform Building Code*, the *International Residential Code*, and the *International One and Two Family Dwelling Code*). Basically this will require an ASTM E 84 test on both the VIP (core material with its metal foil envelope) and the encapsulating polyurethane foam.

Since foam plastics are employed in the panel construction, Section 2603.4 of the IBC will also require the use of a thermal barrier on the ceiling side of the VIP and the use of an ignition barrier on the attic side. Although the proposed construction appears to address these requirements, additional end-use type fire testing may be needed to establish acceptable fire performance or the design of the panel may need to be revised. Some issues of concern are:

1) The ability of the gypsum board to remain in place during a fire needs to be established and;
2) There are concerns with the effectiveness of the gypsum wallboards in protecting the encapsulating foam and the VIP in the proposed use configuration (the effectiveness thermal barrier and ignition barrier would appear to be compromised at the joint with the framed opening). Section 2603.7 of the code mentions some end-use type fire tests that might serve as a starting point in determining what type of test might be conducted to address the issue.

If the panel is to be employed on buildings where roof/ceiling assemblies are required to be fire rated for one or more hours, testing per ASTM E 119 will be needed.

The issue of whether the fire performance will change with age will need to be addressed.

C. Thermal Resistance

Reports of testing to determine the thermal properties of the attic/panel assembly will be needed if the manufacturer wants the evaluation report to include a thermal evaluation. Some suggested test methods include ASTM C 518 for thermal transmission, CGSB 9-GP-15P for thermal conductivity, and ASTM C 236 for thermal resistance. The effects of aging will need to be considered.

The question of whether the VIPs will be manufactured to the size used in the panel or whether the VIP will be cut from VIPs of larger sizes will need to be clarified. If the VIPs are cut from larger sizes of insulation panels, the effects that cutting to size will have on the thermal performance will need to be determined.

D. Quality Assurance

Evidence of continuing special inspections of the manufacturer's fabrication process by an NES listed QA Agency will be required. This includes third-party quality control program, containing

signed copies of Quality Control/Quality Assurance manual(s), covering quality control procedures, inspection and labeling requirements of the panel fabrication. Additionally, since the panel incorporates foam plastic, evidence of continuing special inspections for labeling and quality assurance program governing the manufacture of the foam plastic must be submitted for review. If VacuPanel Inc., does not manufacture the foam plastic used in the panels, additional information will need to be submitted that links the foam plastic manufacturing label program to the end-users quality assurance program.

Please note that the above information is based on the limited information you have provided to us. Please understand that the minimum requirements to substantiate code compliance may change based on the product composition, profile, scope of our evaluation, and intended use.

We hope the above information is useful to you in further acceptance of your product in the construction industry.

I look forward to hearing from you soon.

Sincerely,

Si Farvardin
Program Manager

APPENDIX G

THIRD DOW INSTILL VIP HATCH NES LETTER OF ANALYSIS

National Evaluation Service, Inc.
3203 Leesburg Pike, Suite 600, Falls Church, Virginia 22041-3401
Phone: (703) 931-2187 Fax: (703) 931-6505

January 18, 2002

I am writing to inform you of our preliminary evaluation of your submittal and to outline the code issues related to your proposed technology. Based on the information you provided and your request for an evaluation based on the International Residential Code (IRC), our technical staff offered the following comments:

Subject: Vacuum Insulated Panel Attic Access Panels

I. Technology Description

The Vacuum Insulated Panel Attic Access Panel is an attic access panel that utilizes a vacuum insulated panel (VIP) as its primary component. The VIP is composed of an open-cell polystyrene core, which is enclosed in an evacuated metal foil envelope. To complete the construction of the attic access panel, a ½ inch thick sheet of gypsum wallboard is attached to the ceiling side of the VIP, a 1/4 inch thick sheet of plywood is attached to the topside of the VIP, and the four sides of the VIP are covered with 1 inch wide by 3/4 inch thick wood framing pieces so that the VIP is fully enclosed. A five-gram calcium oxide desiccant(s) is incorporated into the VIP to absorb moisture, which can reduce its R-value and reduce the useful life of the VIP.

II. General

- Test reports must be prepared by an independent testing laboratory acceptable to the NES.
- Technical specifications will be needed on all component materials.
- Copies of the manufacturer's descriptive literature and installation instructions will be needed.

III. Code Areas of Concern

A. Attic Access Opening Requirements:

Section R807 of the *International Residential Code* (*IRC*) requires a rough-framed opening of not less than 22" x 30".

Since the attic access panel measures 30-1/2 inches by 22-1/2 inches, it appears that the rough-framed opening requirements of the *IRC* will automatically be met. The manufacturer's installation instructions should include rough-framed and finished opening details for use with the panel.

B. **Fire Performance Requirements:**

Since it will be exposed to the interior of the building, the attic access panel must be tested to determine its interior finish classification per Section R319 of the *IRC*. At a minimum, this would require finish materials to be tested per ASTM E 84. Provided the gypsum wallboard attached to the ceiling side of the VIP is specified such that it meets the requirements of ASTM C 36, it appears that this requirement will be met.

The VIP (core material with its metal foil sheath) used in the panel construction will need to be tested per ASTM E 84 to show compliance with Section R318.1.1 of the *IRC* (flame-spread rating not more than 75 and a smoke-developed rating of not more than 450). This requirement can be waived if end-use fire tests are conducted (see discussion below).

Section R318.1.2 of the *IRC* requires the use of a thermal barrier on the ceiling side of the VIP and Section R318.2.3 requires the use of an ignition barrier on the attic side of the VIP. Although the gypsum wallboard, plywood, and wood framing pieces attached to the VIP appear to be designed to address these code requirements, there are three issues that will need to be addressed in detail to verify their effectiveness:

1. Documentation will be needed to show that the attachment methods used will meet the code so that the fire protective barriers remain in place under fire conditions. Section R318.1.2 requires mechanical attachment of the gypsum wallboard as required by Chapter 7 of the code (adhesive attachment is prohibited). It should be noted that panel size and construction might not be compatible with the fastening requirements for gypsum wallboard.
2. Similar to Item 1, it is reasonable to expect that the attachment methods of the fire protective barriers have a degree of integrity and durability such that their effectiveness is not easily jeopardized by use of the access door.
3. The configuration of the fire protective barriers must be shown as being effective. In particular, there is a question as to whether the joint between the panel and surrounding framing will diminish the effectiveness of the gypsum wallboard used on the ceiling side of the VIP (i.e., allow a premature exposure of the wood farming members and ultimately the polystyrene core on the sides of the panel to fire).

Section R318.3 allows for specific approval of building products utilizing foam plastics provided such products are fire tested in actual end-use configurations. Such a test can eliminate the need for the ASTM E 84 test on the VIP panel and is needed to address some of the issues regarding the effectiveness of the fire protective barriers. However, since none of the specific tests cited in Section R318.3 of the code appear to be designed to address the end-use configuration of this type product, it is recommended that the manufacturer consult with a code consultant who is expert in the fire sciences to determine the type of test that would best address his needs. The consultant should design the test and related the pass/fail criteria as well as provide background to justify the proposal. We would envision this test being a fire test of an actual ceiling assembly in which the attic access panel is installed in an actual-use type condition. The fire exposure would need to be determined by the consultant, but something along the lines of a room-type crib could be studied.

If other sizes of attic access doors are to be considered, additional testing may be needed.

If the panel is to be employed on buildings where roof/ceiling assemblies are required to be fire rated for one or more hours, testing per ASTM E 119 will be needed.

The issue of whether the fire performance will change with age will need to be addressed.

C. Thermal Resistance

Reports of testing to determine the thermal properties of the attic/panel assembly will be needed if the manufacturer wants the evaluation report to include a thermal evaluation. Some suggested test methods include ASTM C 518 for thermal transmission, CGSB 9-GP-15P for thermal conductivity, and ASTM C 236 for thermal resistance. The effects of aging will need to be considered.

The question of whether the VIPs will be manufactured to the size used in the panel or whether the VIP will be cut from VIPs of larger sizes will need to be clarified. If the VIPs are cut from larger sizes of insulation panels, the effects that cutting to size will have on the thermal performance will need to be determined.

D. Quality Assurance

Evidence of continuing special inspections of the manufacturer's fabrication process by an NES listed QA Agency will be required. This includes third-party quality control program, containing signed copies of Quality Control/Quality Assurance manual(s), covering quality control procedures, inspection and labeling requirements of the panel fabrication.

Please note that the above information is based on the limited information you have provided to us. Please understand that the minimum requirements to substantiate code compliance may change based on the product composition, profile, scope of our evaluation, and intended use.

We hope the above information is useful to you in further acceptance of your product in the construction industry.

I look forward to hearing from you soon.

Sincerely,

Si Farvardin
Program Manager

APPENDIX H

WACKER VIP HATCH
NES LETTER OF ANALYSIS

National Evaluation Service, Inc.

5203 Leesburg Pike, Suite 600, Falls Church, Virginia 22041-3401
Phone: (703) 931-2187 Fax: (703) 931-6505

March 21, 2002

I am writing to inform you of our preliminary evaluation of your submittal and to outline the code issues related to your proposed technology. Based on the new information you provided and your request for an evaluation in accordance with the International Residential Code (IRC), our technical staff offered the following comments:

Subject: Vacuum Insulated Panel Attic Access Panels

I. Technology Description

The Vacuum Insulated Panel Attic Access Panel is an attic access panel that utilizes a vacuum insulated panel (VIP) as its primary component. The VIP is composed of a core consisting of Wacker WDS® microporous thermal insulation which is enclosed in an evacuated envelope of polyethylene-polyamide film or aluminum foil. To complete the construction of the attic access panel, a ½ inch thick sheet of gypsum wallboard is attached to the ceiling side of the VIP, a 1/4 inch thick sheet of plywood is attached to the topside of the VIP, and the four sides of the VIP are covered with 1 inch wide by 3/4 inch thick wood framing pieces so that the VIP is fully enclosed.

II. General

- Test reports must be prepared by an independent testing laboratory acceptable to the NES.
- Technical specifications will be needed on all component materials.
- Copies of the manufacturer's descriptive literature and installation instructions will be needed.

III. Code Areas of Concern

A. Attic Access Opening Requirements:

Section R807 of the *International Residential Code* (*IRC*) requires a rough-framed opening of not less than 22" x 30".

Since the attic access panel appears to be 30-1/2 inches by 22-1/2 inches, it appears that the rough-framed opening requirements of the *IRC* will automatically be met. The manufacturer's installation instructions should include rough-framed and finished opening details for use with the panel.

B. Fire Performance Requirements:

Since it will be exposed to the interior of the building, the attic access panel must be tested to determine its interior finish classification per Section R319 of the *IRC*. At a minimum, this would require finish materials to be tested per ASTM E 84. Provided the gypsum wallboard attached to the ceiling side of the VIP is specified such that it meets the requirements of ASTM C 36, it appears that this requirement will be met.

The VIP (core material with each of the enclosing envelope types) used in the panel construction will need to be tested per ASTM E 84 to show compliance with Section R320 of the *IRC* (flame-spread rating no more than 25 and a smoke-developed rating of not more than 450).

If the panel is to be employed on buildings where roof/ceiling assemblies are required to be fire rated for one or more hours, testing per ASTM E 119 will be needed in which the attic access panel is incorporated into the ceiling membrane of the fire resistance rated roof/ceiling assembly.

The issue of whether the fire performance will change with age will need to be addressed.

C. Thermal Resistance

Reports of testing to determine the thermal properties of the attic/panel assembly will be needed if the manufacturer wants the evaluation report to include a thermal evaluation. Some suggested test methods include ASTM C 518 for thermal transmission, CGSB 9-GP-15P for thermal conductivity, and ASTM C 236 for thermal resistance. The effects of aging will need to be considered.

The question of whether the VIPs will be manufactured to the size used in the panel or whether the VIP will be cut from VIPs of larger sizes will need to be clarified. If the VIPs are cut from larger sizes of insulation panels, the effects that cutting to size will have on the thermal performance will need to be determined.

D. Quality Assurance

A copy of the manufacturer's QA manual is needed to indicate that the fabrication process will be performed in a consistent manner.

Please note that the above information is based on the limited information you have provided to us. Please understand that the minimum requirements to substantiate code compliance may change based on the product composition, profile, scope of our evaluation, and intended use.

We hope the above information is useful to you in further acceptance of your product in the construction industry.

I look forward to hearing from you soon.

Sincerely,

Si Farvardin
Program Manager