Fastening Systems for Continuous Insulation

Final Report 10-11
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Fastening Systems for Continuous Insulation

Final Report

Prepared for the

New York State Energy Research and Development Authority

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NOTICE

ABSTRACT AND KEY WORDS

When insulating a steel-framed exterior wall in cold climates, it is usually necessary to provide continuous insulation on the exterior of the studs to reduce the effect of thermal bridging. As energy codes continue to become more stringent, the thickness of the continuous installation has increased. The increased insulation thickness, however, introduces several problems for building designers, such as window and door jambs needing to be extended, siding manufacturers' warranties being voided when more than one inch of continuous insulation is used, and heavier siding products causing fasteners to fail under their weight.

The objective of this study was to develop attachment techniques and materials for securing building cladding and continuous insulation to above-grade, steel-framed walls of single family and multifamily buildings. The methodology included a review of existing building codes to identify state-wide design cladding loads for setting performance requirements for fasteners, an assessment of constructability issues to ensure that proposed fastener solutions are adoptable by building trades, and the development and submittal of a code change proposal, including a prescriptive table of fasteners for attaching various claddings to framing over continuous insulation for common building types.

The code change proposal was submitted to New York Department of State and approved by the code council for the 2010 New York Energy Code scheduled to take effect December 14, 2010.

Key Words: energy code, continuous insulation, fasteners, cladding

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SUMMARY

The use of continuous rigid foam insulation on a building's exterior wall presents a challenge to builders, especially when thickness exceeds two or more inches, eliminating the possibility of using standard fasteners to attach cladding to the building structure. The weight of the siding, along with continuous insulation changes the forces on the fastener in addition to the seismic and wind loads that already exist. Yet, there has been a lack of definition within the residential building code for the best use of fasteners under these conditions where such insulation is used.

This study, the result of an investigative project, provides specifications of fasteners for use on up to four inches of continuous rigid insulation. It fills a void that currently exists within residential building codes. The conclusions reached in this report help to validate new code language. This new language can and should be added to current and future building codes, such as the International Building Code (IBC) and the International Residential Code (IRC). These conclusions have been submitted to the Energy Conservation Construction Code of New York State (NYECCC) as part of this project. The project's findings validate the use of up to four inches of continuous rigid foam insulation over steel studs.

A GUIDE TO THIS REPORT

This report contains four major Sections and three Appendices. Section 1 identifies relevant building codes from the national level to the New York State code and discusses manufacturers' recommendations for proper attachment of different cladding materials. Section 2 covers the use of plastic fasteners as an option for attaching cladding and discusses the methods used to determine validity. Section 3 explores attachment issues that arise from the use of 2 or more inches of continuous rigid foam insulation. Section 4 provides a prescriptive table of fasteners and developed code proposal language, along with the lab test plan. Tables and figures included throughout the report illustrate key points and provide more detail. Appendix A includes the ICC Model Building Code Proposals for the 2012 IBC and IRC. Appendix B details the ICC (International Code Council) Model Building Code Proposals for the 2012 IBC and IRC. Appendix C contains the full test lab report detailing the outcome of specific fasteners, as tested in a number of cladding scenarios. The following paragraphs describe the report in more detail.

<u>Section 1. Review of Building Codes and Performance Requirements of Cladding Fasteners</u>

This section reviews the performance requirements of cladding fasteners as they relate to manufacturer recommendations. It reviews current and future building codes as they pertain to cladding fasteners, and constructability issues related to siding over thick layers of foam insulation. It also presents a prescriptive table of fasteners for attaching cladding to framing over continuous insulation.

The project team reviewed existing code language to determine what areas lacked key information or tables concerning attaching cladding to cold form steel studs. The following current and past building codes were reviewed: International Building Code (IBC); International Residential Code (IRC); and, Energy Conservation Construction Code of New York State (NYECCC).

The code review showed that information was available for attaching cladding, but that codes did not directly address the use of an additional thick layer of continuous insulation to the wall assembly, or whether the cladding fastener can withstand the dead load from the weight of the siding and continuous insulation (that produces a shear load applied to the fastener).

The IBC and IRC typically defer either to engineering analysis or to manufacturer instructions for cladding fastener specification. Section 4 addresses both of these issues through extensive lab testing and with the development of a fastener table and code language.

Section 2. Review of Plastics for Fasteners

The report also investigates the fact that plastic fasteners currently have limited use in current fastener trends for attaching cladding materials. Plastic fasteners have some limitations in their ability to penetrate steel studs or wooden sheathing, and withstand shear forces.

It is clear, however, that plastic fasteners have been engineered to perform at a high level, while withstanding harsh conditions. Flame retardance, high impact strength, low water absorption, and high tensile strength are features whose use would be applicable to a residential construction application one day.

Materials that serve as substitutes for metal products are particularly encouraging for potential use in a construction application. There appears to be a number of materials that could be promising in the future development of a plastic fastener for the intended application of attaching cladding.

Section 3. Constructability Issues

Newport Ventures brought together a variety of contractors to help identify the constructability issues that the additional thickness of rigid foam insulation would present. Additional research was conducted through phone interviews and site visits.

Testing confirmed that the direct attachment to studs and the hat channel/furring method offer technically justified solutions. Contractors raised concerns about whether they would be able to access appropriate fasteners in a timely manner and about the additional time in assembly required by using certain fasteners like screws for attaching cladding.

To help address those two issues and many more, researchers developed a table that offers suggested solutions that account for structural and performance concerns, reduce site construction time, and minimize the necessity of impromptu solutions that may differ from builder to builder.

Some specific constructability issues investigated included:

- blind connection of fasteners;
- outside/inside corners; and
- window and door jambs.

Section 4. Develop a Prescriptive Table of Fasteners for attaching Cladding to Framing over Continuous Insulation and Develop Code Proposal

This section brings together the findings from the research project to develop (1) a prescriptive table of fasteners for attaching cladding to framing over continuous insulation and (2) code language for submission to future building code updates. To quantify the tables, researchers tested a large range of fasteners and different wall assemblies that potentially could be used out in the field.

Project researchers also completed testing to determine shear and withdrawal performance of siding connections through varying thicknesses of foam sheathing up to four inches thick. Results met or exceeded testing requirements.

The adoption of new code language is necessary to provide siding connection solutions applicable to light-frame cold-formed steel construction, since energy codes require the use of continuous insulation under these circumstances. Tables that have been developed and or modified from code books include, but are not limited to, minimum siding fastening requirements for (1) direct attachment over foam sheathing for the support of siding dead load and (2) minimum fastening requirements of different furring materials over foam sheathing to support siding dead load as well. In both of these instances, the tables include reference to cold formed steel studs.

SECTION 1 - REVIEW OF BUILDING CODES AND PERFORMANCE REQUIREMENTS OF CLADDING FASTENERS

When insulating a steel-framed exterior wall in cold climates, it is usually necessary to provide continuous insulation on the exterior of the studs to reduce the effect of thermal bridging. As energy codes continue to become more stringent, the thickness of the continuous installation has increased. Yet, the increased thickness required introduces several problems for building designers, such as the possibility that window and door jambs might need extending, that siding manufacturers' warranties might be voided when more than one inch of continuous insulation is used, and how to select fasteners that can support siding dead load while also extending through a thick layer of continuous insulation.

The amount of continuous insulation is dictated by building energy codes, and generally determined according to building type, framing material, and climate zone. For example, the New York Energy Conservation and Construction Code's (NYECCC) current requirements for R-values of continuous insulation for commercial and multi-family buildings range from zero to 7.5 depending on climate zone and building type. These values are based on prescriptive requirements of ASHRAE 90.1-2004 (the most widely referenced standard for building energy codes in the nation), which is referenced by the NYECCC. Looking forward, ASHRAE 90.1- 2007 requires a minimum of R-7.5 of continuous insulation for all above-grade steel-framed walls in New York, regardless of climate zone. ASHRAE is now in process of drafting 90.1-2010, and is considering further substantial increases in the continuous insulation requirements for exterior walls – increases that are eventually likely to apply to New York State buildings.

A significant implementation challenge of using increasingly higher levels of continuous insulation is the lack of specifications for the type of fastener and siding installation details needed. Thus, the engineer, architect, builder, and contractor are left to confront this challenge without clear guidance or supporting siding manufacturer instructions.

The overall objective of the project described in this report is to develop techniques for securing building cladding and continuous insulation to above-grade, steel-framed walls of single family and multifamily buildings up to seven stories. The first step was to conduct a thorough review of building codes to identify fastener performance requirements. Subsequent tasks included analyzing constructability issues to ensure that proposed fastener solutions are adoptable by the building trades and to developing a prescriptive table of fasteners for various claddings over continuous insulation up to four inches thick for common steel-frame wall assemblies.

RELEVANT BUILDING CODES

Five codes were reviewed under this task. These include the 2007 New York Energy Conservation Construction Code (NYECCC), the 2007 New York Residential Code (NYRC), the 2009 International Residential Code (IRC), 2007 New

York Building Code (NYBC), and the 2009 International Builders Code (IBC). Of these, two codes contained language that directly impact fastener selection in New York State: the NYRC and the NYBC. Because the NYRC and NYBC are based on the 2006 IRC and 2006 IBC, it is assumed that as New York codes are updated in the future, those updates will be based on future versions of the IRC and IBC. Further, future versions of the IRC and IBC are expected to offer increasingly more informative text. To compile the most updated building code text on performance requirements for fasteners, excerpts were taken from the 2009 IRC and 2009 IBC. Emphasis was given to vinyl, fiber-cement, and wood siding because these are the predominant cladding types. Traditional stucco also has been included, but EIFS synthetic stucco systems are excluded.

Residential Code Language

2009 IRC - Section R703 Exterior Covering (ICC, 2009a).

R703.4 Attachments. Unless specified otherwise, all wall coverings shall be securely fastened in accordance with Table R703.4 or with other approved aluminum, stainless steel, zinc-coated or other approved corrosion-resistive fasteners. Where the basic wind speed per Figure R301.2 (4) is 110 miles per hour (49 m/s) or higher, the attachment of wall coverings shall be designed to resist the component and cladding loads…adjusted for height and exposure.

R703.1.2 Wind resistance. Wall coverings, backing materials and their attachments shall be capable of resisting wind loads. Wind-pressure resistance of the siding and backing materials shall be determined by ASTM E330 or other applicable standard test methods. Where wind-pressure resistance is determined by design analysis, data from approved design standards, and analysis conforming to generally accepted engineering practice shall be used to evaluate the siding and backing material and its fastening. All applicable failure modes including bending, rupture of siding, fastener withdrawal, and fastener head pull-through shall be considered in the testing or design analysis. Where the wall covering and the backing material resist wind load as an assembly, use of the design capacity of the assembly shall be permitted.

R703.10.1 (Fiber cement) Panel siding. Vertical and horizontal joints shall occur over framing members and shall be sealed with caulking, covered with battens or shall be designed to comply with Section R703.1. Panel siding shall be installed with fasteners according to Table R703.4 or approved manufacturer's installation instructions.

R703.10.2 (Fiber cement) Lap siding. Lap siding shall be lapped a minimum of 11/4 inches (32 mm) and lap siding not having tongue-and-groove end joints shall have the ends sealed with caulking, installed with an H-section joint cover, located over a strip of flashing, or shall be designed to comply with Section R703.1. Lap siding courses may be installed with the fastener heads exposed or concealed, according to Table R703.4 or approved manufacturers' installation instructions.

R703.11.1 (Vinyl siding) Installation. Vinyl siding, soffit and accessories shall be installed in accordance with the manufacturer's installation instructions.

R703.11.2 Foam plastic sheathing. Vinyl siding used with foam plastic sheathing shall be installed in accordance with Section R703.11.2.1, R703.11.2.2, or R703.11.2.3. Exception: Where the foam plastic sheathing is applied directly over wood structural panels, fiberboard, gypsum sheathing or other approved backing capable of independently resisting the design wind pressure, the vinyl siding shall be installed in accordance with Section R703.11.1.

R703.11.2.1 Basic Wind Speed Not Exceeding 90 Miles Per Hour and Exposure Category B. Where the basic wind speed does not exceed 90 miles per hour (40 m/s), the Exposure Category is B and gypsum wall board or equivalent is installed on the side of the wall opposite the foam plastic sheathing, the minimum siding fastener penetration into wood framing shall be 11/4 inches (32 mm) using minimum 0.120-inch diameter nail (shank) with a minimum 0.313-inch diameter head, 16 inches on center. The foam plastic sheathing shall be minimum 1/2-inch-thick (12.7 mm) (nominal) extruded polystyrene per ASTM C578, 1/2-inch-thick (12.7 mm) (nominal) polyisocyanurate per ASTM C1289, or 1-inch-thick (25 mm)(nominal) expanded polystyrene per ASTMC578.

R703.11.2.2 Basic Wind Speed Exceeding 90 Miles Per Hour Or Exposure Categories C And D. Where the basic wind speed exceeds 90 miles per hour (40 m/s) or the Exposure Category is Cor D, or all conditions of Section R703.11.2.1 are not met, the adjusted design pressure rating for the assembly shall meet or exceed the loads listed in Tables R301.2(2) adjusted for height and exposure using Section R301.2(3). The design wind pressure rating of the vinyl siding for installation over solid sheathing as provided in the vinyl siding manufacturer's product specifications shall be adjusted for the following wall assembly conditions:

1. For wall assemblies with foam plastic sheathing on the exterior side and gypsum wall board or equivalent on the interior side of the wall, the vinyl siding's design wind pressure rating shall be multiplied by 0.39.
2. For wall assemblies with foam plastic sheathing on the exterior side and no gypsum wall board or equivalent on the interior side of the wall, the vinyl siding's design wind pressure rating shall be multiplied by 0.27.

R703.11.2.3 Manufacturer specification. Where the vinyl siding manufacturer's product specifications provide an approved design wind pressure rating for installation over foam plastic sheathing, use of this design wind pressure rating shall be permitted and the siding shall be installed in accordance with the manufacturer's installation instructions.

Residential Commentary. Table R703.4 is only relevant when selecting fasteners for attachment of wall coverings to wood framing, and does not apply to selection of fasteners for attachment of wall coverings directly to steel framing. While no prescriptive information is provided for attachment to steel framing, the 2009 IRC has identified relevant test methodology that should be pursued (e.g. ASTM E 330), deferring to engineering design regardless of the framing material when the basic wind speed exceeds 110 mph (R703.4). The IRC also provides some prescriptive fastener information for continuous insulation (i.e. foam plastic sheathing), but does not provide the same level of prescriptive detail for fasteners to attach siding over continuous insulation. In these cases, the IRC often defers to manufacturer recommendations for fastener selection. Finally, the IRC permits the IBC to be used as an alternative compliance path when using engineering analysis to demonstrate ability of the building to withstand design loads (R301.1.1).

Building Code Language (non-residential)

2009 IBC - Chapter 14 - Exterior Walls (ICC, 2009b)

1403.4 Structural. Exterior walls, and the associated openings, shall be designed and constructed to resist safely the superimposed loads required by Chapter 16 (note: Chapter 16 addresses structural design, including dead, live, seismic, and wind loads).

1405.14 Vinyl siding. Vinyl siding conforming to the requirements of this section and complying with ASTM D 3679 shall be permitted on exterior walls of buildings located in areas where the basic wind speed specified in Chapter 16 does not exceed 100 miles per hour (45 m/s) and the building height is less than or equal to 40 feet (12 192 mm) in Exposure C. Where construction is located in areas where the basic wind speed exceeds 100 miles per hour (45 m/s), or building heights are in excess of 40 feet (12 192 mm), tests or calculations indicating compliance with Chapter 16 shall be submitted. Vinyl siding shall be secured to the building so as to provide weather protection for the exterior walls of the building.

1405.14.1 Application. The siding shall be applied over sheathing or materials listed in Section 2304.6…. Siding and accessories shall be installed in accordance with approved manufacturer's instructions. Unless otherwise specified in the approved manufacturer's instructions, nails used to fasten the siding and accessories shall have a minimum 0.313-inch (7.9 mm) head diameter and 1/8-inch (3.18 mm) shank diameter. The nails shall be corrosion resistant and shall be long enough to penetrate the studs or nailing strip at least 3/4 inch (19 mm). Where the siding is installed horizontally, the fastener spacing shall not exceed 16 inches (406 mm) horizontally and 12 inches (305 mm) vertically. Where the siding is installed vertically, the fastener spacing shall not exceed 12 inches (305 mm) horizontally and 12 inches (305 mm) vertically.

1405.16 Fiber-cement siding. Fiber-cement siding complying with Section 1404.10 shall be permitted on exterior walls of Type I, II, III, IV and V construction for wind pressure resistance or wind speed exposures as indicated by the manufacturer's listing and label and approved installation instructions. Where specified, the siding shall be installed over sheathing or materials listed in Section 2304.6 and shall be installed to conform to the water-resistive barrier requirements in Section 1403. Siding and accessories shall be installed in accordance with approved manufacturer's instructions. Unless otherwise specified in the approved manufacturer's instructions, nails used to fasten the siding to wood studs shall be corrosion-resistant round head smooth shank and shall be long enough to penetrate the studs at least one inch (25 mm). For metal framing, all-weather screws shall be used and shall penetrate the metal framing at least three full threads.

1405.16.1 Panel siding. Vertical and horizontal joints shall occur over framing members and shall be sealed with caulking, covered with battens or shall be designed to comply with Section 1403.2. Panel siding shall be installed with fasteners in accordance with the approved manufacturer's instructions.

1405.17 Fastening. Weather boarding and wall coverings shall be securely fastened with aluminum, copper, zinc, zinc-coated or other approved corrosion-resistant fasteners in accordance with the nailing schedule in Table 2304.9.1 or the approved manufacturer's installation instructions. Shingles and other weather coverings shall be attached with appropriate standard- shingle nails to furring strips securely nailed to studs, or with approved mechanically bonding nails, except where sheathing is of wood not less than 1-inch (25 mm) nominal thickness or of wood structural panels as specified in Table 2308.9.3(3).

DISCUSSION OF CODE REQUIREMENTS

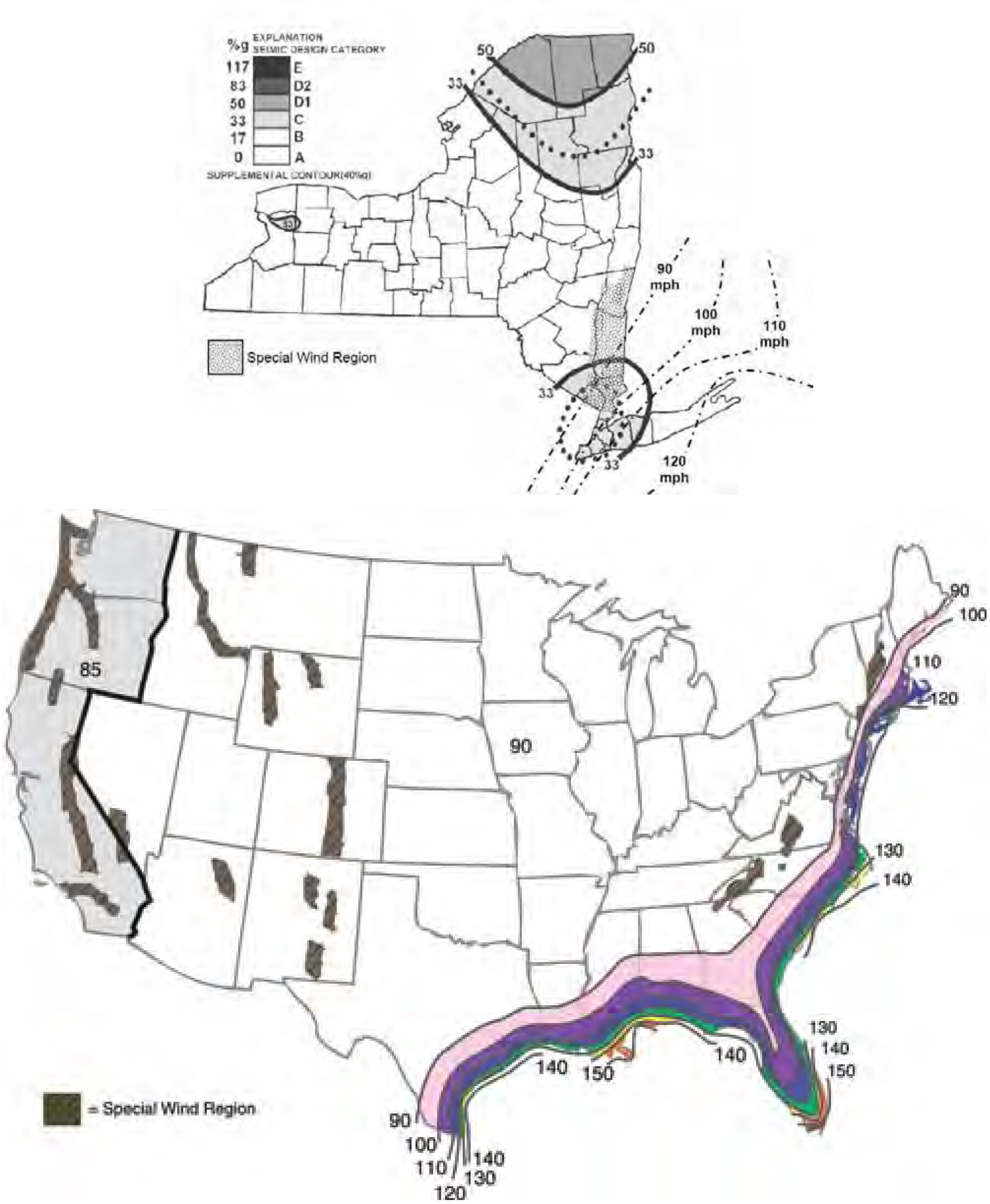
The preceding code excerpts focused on the specific sections dealing with fastener selection. These excerpts did not include numerous other sections that relate to siding and cladding, since they generally cover other design issues such as weather resistant coverings. This discussion focuses on the load requirements of fasteners.

Of the residential and building codes reviewed, the 2009 IRC provides the most guidance to a designer when specifying fasteners for attaching siding to steel framing. This code specifies the relevant classes of loads (component and cladding) and the testing methodology to follow when determining wind loads (ASTM 2002). Other than this mention, the code generally defers to manufacturers to provide guidance on fastener selection. Further, wind comprises only one of the loads to consider. Codes generally prescribe minimum load capacities for materials and assemblies based on flood, seismic, wind, dead, snow, and live loads (e.g., loads affected by building occupancy). For siding attachment within the scope of this study (vinyl or aluminum, traditional stucco, wood, and fiber-cement), only seismic, wind, and dead loads are relevant.

Seismic loads can be determined based on seismic maps supplied in the NYBC or IBC. Chapter 16 of the IBC requires cladding to resist seismic loads (1604.9) and provides a reference to calculation methodology for seismic loads on various building components. In general, ASCE 7-05, "Minimum Design Loads for Buildings and Other Structures," (ASCE 2005) is the source that the IBC references for determining seismic loads for all building components, including cladding. A review of ASCE 7-05 suggests that resistance to seismic loads is provided by embedment of the fastener into substrate, and is not a function of the length of the fastener. Hence, increasing the depth of the continuous insulation installed under the cladding will not affect the standard methodology, which is now followed for determining performance requirements of cladding fasteners.

Wind loads are determined based on wind zone maps supplied in both the NYBC and NYRC (see Figure 1 for wind zone maps). With fasteners, the primary concern with wind is the fastener's ability to resist pull-out forces that affect the embedment of the fastener in the stud or sheathing.

Figure 1. Wind Zone Maps



Chapter 16 of the 2009 IBC also references ASCE 7-05 for the calculation of wind loads expected to impact cladding. Additionally, for the case of fasteners attached to steel framing, AISI S200-07, "North American Standard for Cold-Formed Steel Framing - General Provisions," requires screws to penetrate the steel-framing member with at least three exposed threads on the interior side, in wind speeds up to 150 miles per hour. Because #8 and #10 are the most common attachment screws, this prescription covers most attachments of siding to steel framing. For the case of fasteners attached to wood- based substrate combinations (e.g., sheathing or sheathing + stud), ANSI/AF&PA NDS-2005 “National Design Specification for Wood Construction,” (ANSI/AF&PA 2005) which is referenced in the 2009 IRC, 2007 NYRC, 2009 IBC, and 2007 NYBC, provides guidance for resisting pull-out forces. This standard provides a calculation procedure for specification of fasteners depth, size, and schedule as a function of depth of penetration into the wood substrate. When fasteners achieve at least a ¾ inch penetration in the wood substrate, designers can elect to avoid the calculations and instead rely on a prescriptive table for fastener selection.

Thus, for most circumstances, wind and seismic loads on cladding can be identified by referencing current codes and standards. Because embedment of fasteners into wood or steel structural members creates wind and seismic load resistance, and because methodology exists for determining the required embedment, it is possible to follow conventional methods to develop prescriptive fastener requirements to resist wind and seismic loads. Therefore, the only additional structural concern with adding a thick layer of continuous insulation to the wall assembly is whether the cladding fastener can withstand the dead load from the weight of the siding and continuous insulation.

As the previous code excerpts indicate, the IBC and IRC typically defer either to engineering analysis or to manufacturer instructions for cladding fastener specification. A review of manufacturer recommendations is therefore necessary to understand prescriptive fastener requirements for siding.

MANUFACTURER RECOMMENDATIONS

To carry out this project required contacting numerous siding manufacturers and referencing relevant installation manuals in order to compile a listing of the fasteners typically referenced within specific siding installation instructions. The left-hand column of Figure 2 provides a list of six siding options with common fastener options displayed on the right. These are suggested fastening recommendations only. Pull-out or withdrawal capacity of the selected fastener should be verified with respect to anticipated wind load, desired safety factor, and building code requirements. Although not part of the scope of this project, brick and stone requirements are shown for comparison purposes. Though nails are generally not used for attachment of siding directly to steel studs, Figure 2 includes them to allow for assemblies where siding could be fastened to wood furring strips that are fastened to steel studs.

Note that many manufacturer installation instructions limit the thickness of continuous insulation to one inch. It is assumed that this current limitation is based on lack of knowledge of the loading on the fastener that would be incurred with greater thicknesses. This project seeks to address this limitation by developing this information.

Figure 2. Industry or Manufacturer Fastener Recommendations

	Screws	Nails	Pins	Miscellaneous
Vinyl Siding (VSI, 2007)	Use noncorrosive, self-tapping screws at least 1-1/8" long, with at least 3/8" dia. head and 1/8" dia. shaft. Screws should penetrate a minimum of 3/4" into framing or furring and should be size #8, truss head or pan head.	Nail heads should be 5/16" minimum in diameter. Shank should be 1/8" in diameter. Nails should penetrate a minimum of 3/4" into a nailable surface.	Staples must not be less than 16-gauge semi-flattened to an elliptical cross-section. Pins should penetrate not less than 3/4" into framing or furring.	ASTM D4756-06, Standard Practice for Installation of Rigid Poly (Vinyl Chloride) (PVC) Siding and Soffit, provides standard guidance, but also defers to manufacturer installation instructions. For all fasteners, allow approx. 1/32" clearance between the fastener head and the siding panel.
Fiber Cement (CT, 2008)	Ribbed, bugle-head corrosive-resistant screws, (#8-18, 1-5/8" 16ga x 0.375" HD) Fiber cement must be attached to the metal framing members (recommended at 16" o.c.). Screws must penetrate into the metal framing a minimum of 1/4" or three threads.	Non-corrosive double hot-dipped galvanized or stainless steel nails. The nail head must lay on the surface of the siding – do not over-drive the nails or nail on angle.	Pneumatic pins are available for certain applications. ET & F Panelfast® nails or equivalent (0.10" shank x 0.313" HD x 1-1/2" long). Nails must penetrate minimum 1/4" into metal framing (JH, 2008)	Do not use D-head nails, staples and/or construction adhesives to install fiber cement siding.
Wood Lap (WRCLA, 2007)	0.23" dia. trim head with #3 drill point - tapping screw thread, threaded 2/3 of overall length. "When wood siding is installed over metal studs, provide 2x nailers of sufficient spacing and size to meet the nailing requirements. This procedure is sometimes used when wood siding is installed over continuous insulation."	The diameter of nail is dependent upon the type and thickness of siding. Use corrosion resistant nails with sufficient length to penetrate wood to a minimum depth of 1 ¼ inches. For best results, use "splitless" ring shank siding nails, which have thin shanks and blunt points to reduce splitting.	No recommendations found.	"Rigid foam sheathing can cause moisture to accumulate on the back of siding and cause staining, buckling and damage to finish coats. As a result, it is recommended that furring strips are used to create an air space between the sheathing and siding" (regardless of whether the structural framing is wood or steel)
Anchored Brick and Stone Veneer	Attach drill bolt/U-clip/ triangle tie assembly anchor to the steel stud web with self-tapping 10-	No recommendations found.	No recommendations found.	Anchors and ties should connect directly to the steel stud framing without relying on

	Screws	Nails	Pins	Miscellaneous
	16 x 1-1/2" hex head screws with a 5/8" galvanized bonded E.P.D.M. washer and a 5/16" hex washer head. Various drill bolt and triangle tie lengths are available to accommodate sheathing up to 4-1/2" thick. Drill Bolts are 1/2" dia. U-Clip is 14 gage. (Heckman, 2009)			the compressive strength of insulating sheathing to transfer positive wind pressure to the steel studs (Owens Corning, 2006)
Direct Adhered Brick and Stone Veneer (Environmental StoneWorks, 2008)	Self tapping screws with minimum 3/8" head of sufficient length to penetrate at least 3/8" beyond metal surface. The lath must be anchored with corrosion resistant screws that have a minimum shank dia. of 0.190". Screws shall be an approved type long enough to penetrate into wood framing not less than 5/8".	4D nail with a ¼"-7/16" head depending on lath choice.	No recommendations found.	Staples can be used to attach lath if the crown is a minimum of 7/8" with a leg length of 7/8"-1 5/8" dependent on lath choice. OSB or plywood should be attached securely to metal studs according to code requirements.
Stucco (Mediterranean Colors)	Minimum #8 Type S or S-12 wafer head, fully threaded, corrosion resistant screws with minimum 3/8" penetration into studs.	Wood Framing -- minimum 11 gauge, 7/16" dia. head, galvanized roofing nails with minimum ¾" penetration into studs; or minimum #8 Type S wafer head, fully threaded, corrosion resistant screws with minimum ¾" penetration into studs.	No recommendations found.	Tie wire—18 gauge galvanized and annealed low-carbon steel in compliance with ASTM A641 with Class I coating.

In addition to the recommendations in Figure 2, some other installation instructions should be considered for specific siding types including vinyl siding, fiber cement, and wood lap.

Vinyl Siding

- "Vinyl siding must be applied over a rigid sheathing that provides a smooth, flat surface or an underlayment (such as wood, wood composition, rigid foam or fiber sheathing) that is no more than 1" thick. Vinyl siding cannot be applied directly to studs." (CT, 2009)

Fiber Cement

- "Siding must be installed to structural framing when using non-structural sheathing. Non-structural sheathing thickness should not exceed 1”…. Take extra care when installing fiber cement over foam sheathings. Foam sheathings may crush, especially when they are hand-nailed…. If fiber cement siding is installed over a non-nailable substrate such as foam sheathing, pre-drill the holes at the corners to avoid accidental breakage. Panels must be nailed into structural framing (16" or 24" O.C.)." (CT, 2008)
- “It is recommended that siding be fastened into studs or framing. Refer to ICC-ES report ESR-1668…for specific fastening recommendations. Fastening into other structural materials may be acceptable if in accordance with local building codes and/or project conditions.” (CT, 2008)

Wood Lap (WRCLA, 2007)

- “Stainless steel nails are the best choice, especially if the siding is to be finished with transparent or semitransparent stain. Use No. 304 stainless for general siding applications and No. 316 for seacoast exposures.... Hot-dipped galvanized, as per ASTM A153, aluminum and stainless steel fasteners are corrosion-resistant and can be used to fasten Western Red Cedar. Other types of fasteners (including electroplated and mechanically galvanized) are not recommended.”
- Hand nailing is preferred over pneumatic nailers, and pre-drilling at mitered corners, near edges and near ends, may be necessary to avoid splitting.
- “Siding should be fastened to each stud or blocking with nails spaced at a maximum of 24 inches on center. Nail placement depends on the siding pattern and width…. Fasten the siding securely without preventing it from moving in response to the moisture content in the air.”

Dead Load of Siding

As mentioned earlier, fastener choice is highly dependent on the weight of the material to be adhered to the building. Figure 3 contains the weights of common siding materials. Note that this project focuses on vinyl, fiber cement, wood lap, and three-coat stucco.

Figure 3. Siding Material Weights

Siding Material	Typical Weight of Siding Material
Vinyl Siding	1.4-1.6 PSF
Fiber Cement	2.3 PSF
Wood Lap	2.5-3.1 PSF
Anchored Brick and Stone Veneer	47.0 PSF
Direct Adhered Brick and Stone Veneer	9.0-15.0 PSF
Stucco	10.4 PSF

The range of weights in Figure 3 complicates the later task of developing recommendations for fastening siding over continuous insulation independent of siding type. Selecting the highest weight would be conservative but would penalize materials such as vinyl at the lower end of the weight spectrum. A more reasonable approach for the later task would be to develop a range of fastener solutions according to a range of weights. For example, one set of fastener solutions could be developed for lightweight siding, perhaps 3 PSF or lower. Similarly, solutions for a middle range and for heavy materials could be developed.

Fastener Options

Taking the loads and current practices into consideration, there are several options that can be used for fastening cladding to steel framing. These include nails (with wood substrate), screws, and pins.

Generally, nails could be acceptable if some type of wood-based surface was used over or under the exterior insulation. Oriented strand board (OSB) sheathing and wood furring strips should be investigated.

Screws are generally the preferred method for attaching cladding or furring strips to steel-framed walls. In addition to Phillips-head, screws come with square-drive and star-drive heads that allow higher torque driving without stripping the head. Numerous mechanical fastener companies produce screws that meet these requirements and are long enough for installation purposes.

Pneumatic pin fasteners have the potential to speed installation for a variety of siding materials over continuous insulation. One current setback for pins is the limitation of the pneumatic fasteners themselves. Currently the most common maximum length that a framing gun can fire is up to 3 ½ inches. Longer pins would need to be available, or this fastener type would be limited to assemblies with at most 2 inches of exterior continuous insulation.

SUMMARY

Codes have historically left much of the prescriptive requirements for siding attachment to manufacturers' installation recommendations. Only recently have codes begun to question whether all applicable loads were being addressed.

Further, the recommendations of manufacturers and code requirements have developed over the years based mostly on experience. These recommendations were never intended to apply to the more recently developed assemblies with thick layers of exterior continuous insulation.

The steel-framing industry (as well as other industries) is in an interesting position. Many of the current prescriptive fastening requirements or methods could be judged as insufficient if subjected to a thorough engineering load analysis. At the same time, the practices in use today have been proven to work through field application. Thus, it is not necessary to update current manufacturer fastener requirements for cladding installed on top of up to one inch of exterior continuous insulation. Still, the addition of greater than one inch of exterior continuous insulation typically takes designers outside the scope of traditional or accepted practice. Because this project seeks to develop fastener prescriptions that go beyond current building practice, engineering analysis and/or test methods must be employed to determine prescriptions that can be projected to satisfy expected seismic, wind, and dead loads, while achieving a targeted safety factor.

In examining the code requirements and related issues, the only “new” load that needs to be considered in developing prescriptive requirements for cladding fasteners is the dead load induced by the weight of the siding/continuous insulation combination. All other relevant loads on cladding fasteners (i.e., wind and seismic) can currently be determined following the methodologies outlined within codes and standards (e.g., 2009 IBC, which references ASCE7-05).

The next step in this project will be to identify the options that can be used to connect the siding through exterior continuous insulation and to calculate the adequacy of wood-based sheathing to serve as an attachment substrate. Appendix A to Section 1 contains a preliminary description of options. At the same time, the practical limitations of various options will be evaluated, and a test plan will be developed to confirm the performance of options deemed feasible for steel framing.

REFERENCES FOR SECTION 1

Organizations

AF&PA American Forest and Paper Association

ANSI American National Standards Institute

ASCE American Society of Civil Engineers

ASTM American Society for Testing and Materials

CT CertainTeed

ICC International Code Council

JH James Hardie

VSI The Vinyl Siding Institute

WRCLA Western Red Cedar Lumber Association

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APPENDIX A TO SECTION 1 - WALL ASSEMBLY OPTIONS

This Appendix to Section 1 discusses a number of wall assembly options to be considered for attaching siding to a steel-framed structure. Some preliminary illustrations have been provided for clarity.

Case 1. Continuous Insulation Attached Directly To Steel Studs, with Cladding Attached To Steel Studs Through Continuous Insulation. This assembly will be needed for various commercial and residential wall applications, irrespective of the building/wall bracing methods that may be used on some exterior wall applications. This approach is especially important for commercial buildings where the building is a concrete structure, and steel framing is used only within curtain walls.

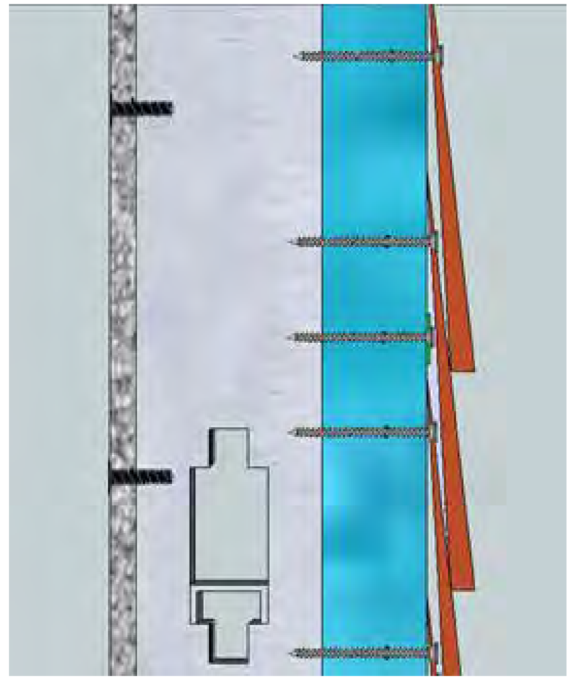


Figure 4. Diagram of Case 1

Case 2. Continuous Insulation and Siding Directly Attached To Structural Sheathing (Nail Base) Only and Structural Sheathing Attached To Steel Framing. In investigating this configuration, typical 7/16 inch OSB and also 3/4 inch OSB sheathing will be considered for nail base purposes.

Case 3. 1x or 2x Wood Furring To Steel Stud Without Structural Sheathing. Use of wood furring is a basic option that avoids many variables for siding attachment, as siding attachments to wood members are well known and developed. Data for this configuration could also be conservatively applied to walls with structural sheathing under the continuous insulation.

Case 4. 1x or 2x Wood Furring To Steel Stud with Structural Sheathing. Having fastener penetration in structural sheathing and steel studs may tend to stiffen and strengthen the fastener so that it can cantilever through thicker foam and hold greater siding weight under shear. This may improve design values and limit fastener sizes and spacing requirements relative to option #3 above.

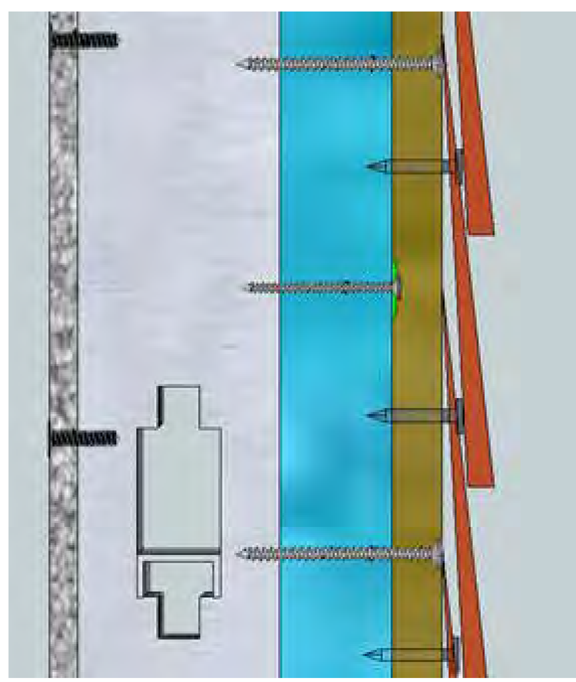


Figure 5. Diagram of Case 3

Case 5. 1x or 2x Wood Furring To Structural Sheathing/Nail Base Only. This configuration allows furring to be attached anywhere and blindly to the wall, except steel studs may interfere with wood furring fastener installation. In this approach, furring can be spaced at 16"oc (as limited by many siding options) whereas steel studs can be spaced at 24 inches. This would allow greater flexibility, but again the thickness of structural sheathing may need to be increased for adequate nail base.

Case 6. Metal Furring Hat Channels Attached Back To Steel Studs Through Continuous Insulation. This approach is similar to the use of 1x or 2x wood furring. The hat channels can also be attached to horizontal Z-channels allowing for ease of installation. Benefits associated with the use of hat channels versus wood furring are lighter weight and longer lengths.

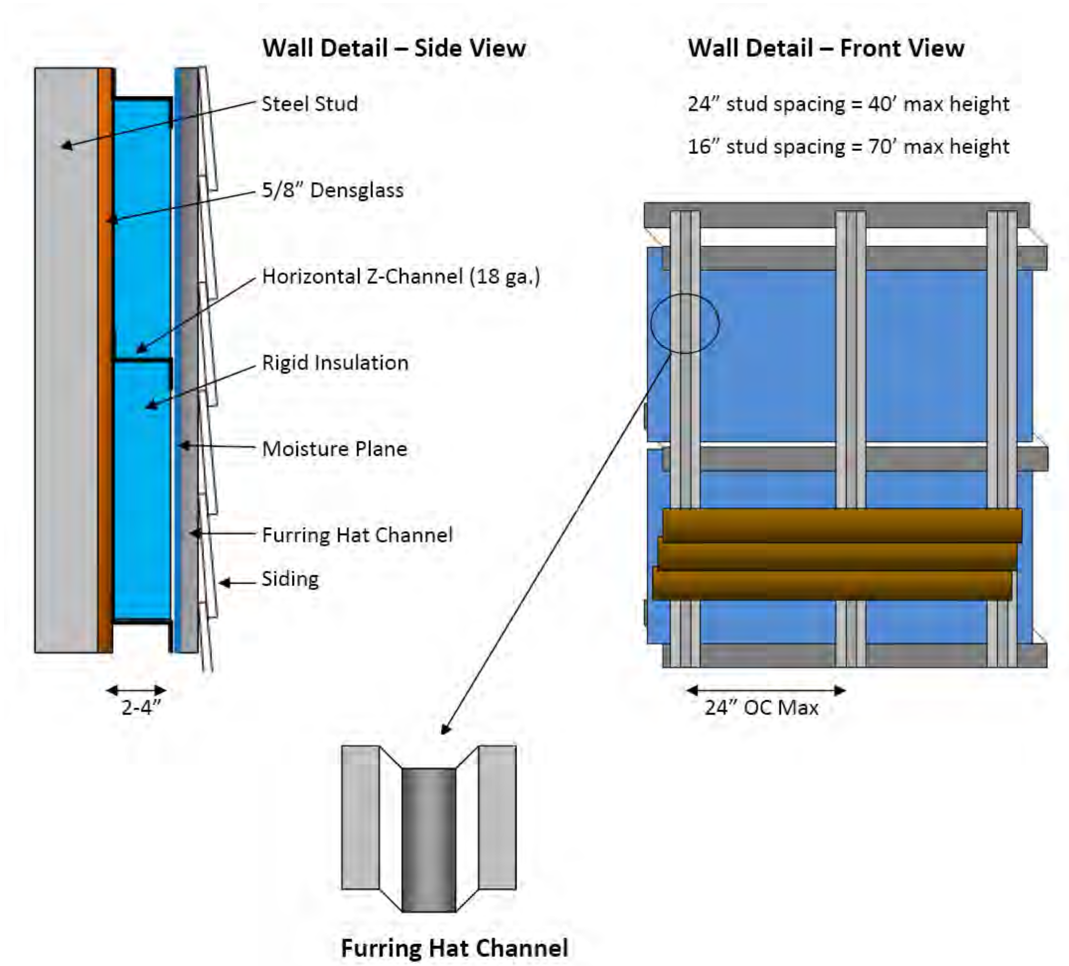


Figure 6. Diagram of Case 6

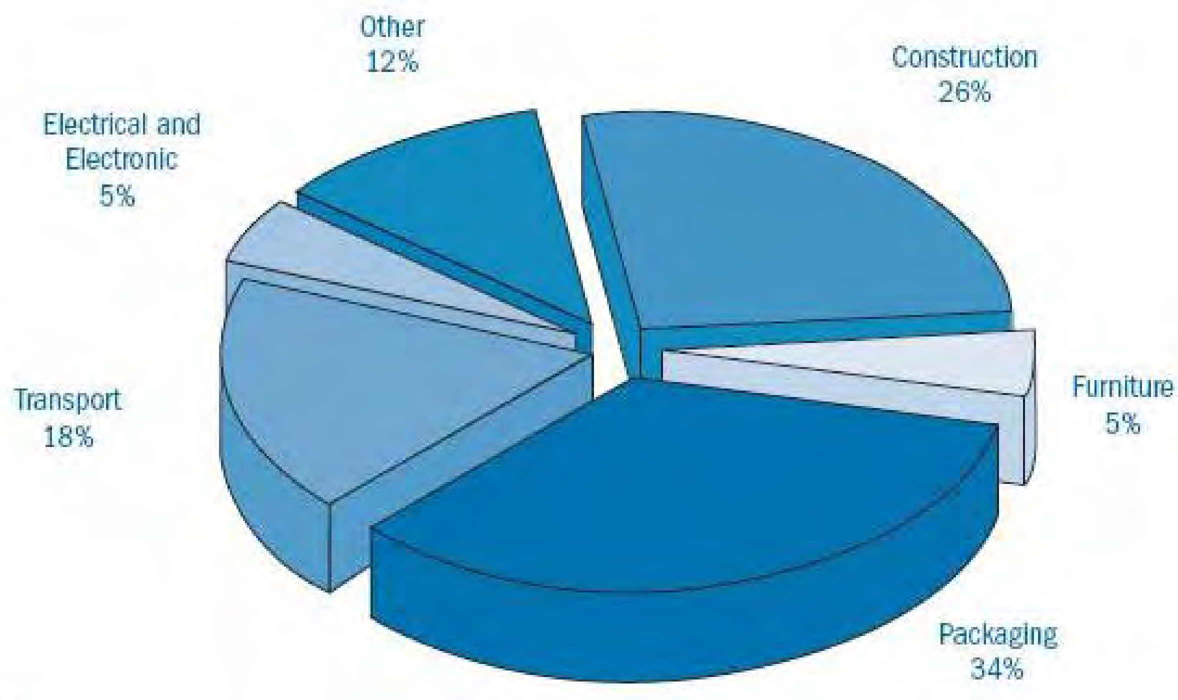
SECTION 2 – REVIEW OF PLASTICS FOR FASTENERS

The plastics industry, the third-largest in the United States, employs over 1.1 million workers and generates $374 billion in annual revenue.[1] Plastics are used in a wide range of industries, including aerospace, building and construction, electronics, packaging, and transportation.

INDUSTRY USAGE

The building industry is the second-largest consumer of plastic material in the United States[2] (See Figure 7). Consequently, it is not surprising that plastics are used in the construction of most building types. They are found in plumbing fixtures, siding, flooring, insulation, panels, doors, and windows. Plastics boast a high strength- to-weight ratio, allowing their use in a number of structural applications as well. It is expected that the use of plastics in the building industry will continue to grow at a rapid pace.

Figure 7. Use of Plastic in Various Market Segments



Source: CPIA

Plastic fasteners themselves serve in a number of applications. Based on the product's features, it may be feasible to use these types of fasteners in some sort of construction application. Plastic fasteners come in a number of different varieties, many with quite impressive characteristics. Plastic fasteners have the same fit standards and dimensional

[1] Society of the Plastics Industry, http://www.plasticsindustry.org
[2] Society of the Plastics Industry, http://www.plasticsindustry.org.

thread class as metal fasteners. In addition, threaded plastic fasteners include bolts, screws, rods, studs, and nuts. Non-threaded fasteners include rivets, pin fasteners, spacers, harnesses, clamps, and grommets, among several others.

The plastic used in fasteners offers a number of attractive characteristics. It is strong, rigid, tolerant of high and low temperatures, resistant to chemicals and corrosion, offers good weatherability, is lightweight, and is often less costly than its metal counterparts. A plastic fastener can have a glass or metallic filler added to its base to improve its strength, stiffness, useful temperature range, and specific gravity.

This section discusses the availability of existing plastic fasteners for the purpose of attaching siding through insulation to a metal structure in residential construction. It also provides an overview of commonly used plastic material in fasteners, as well as an interpretation of any current research literature pertinent to the use of plastic fasteners in residential construction applications.

RESEARCH APPROACH

To begin the investigation, Newport performed a materials review, visited manufacturers' websites, carried out telephone interviews with company representatives, and performed a review of the literature.

First, Newport conducted a brief review of the materials that are commonly used to manufacture plastic fasteners. It was necessary to perform this task because, based on existing knowledge of plastic fastener products, there was some doubt as to whether there are, in fact, any plastic fasteners in the marketplace that are capable of attaching siding through insulation to a steel-framed structure. Thus, gaining an understanding of the materials used to create fasteners was a prudent course of action. The hope was that, based on a material's characteristics, candidates could be identified for the future development of a plastic fastener for the intended application.

Next, Newport viewed manufacturers' websites to determine if there were any products displayed whose intended uses matched, or were at least very closely related to, the application of plastic fasteners.

Newport then conducted phone interviews with one or more qualified representatives from each manufacturer to overcome possible limitations of the internet scan. Such limitations may include the fact that websites may contain marketing information, be out of date, or may fail to display all available products. Moreover, there may be products that were initially intended for some other application that could be used in the application being examined. In addition, it was thought that the phone interviews would enable researchers to gain further insight into a material that might prove promising for use in the future development of a fastener.

Finally, Newport conducted a literature review to identify any current research and development activities that would be relevant to plastic fasteners.

INVESTIGATING PLASTICS FOR FASTENERS

The following paragraphs discuss the following topics:

- Industries served by plastic fastener manufacturers
- Internet scan of commonly used materials
- Internet scan of manufacturers' web sites
- Telephone interviews
- Literature review
- Issues to be overcome

Industries Served by Plastic Fastener Manufacturers

Newport obtained information on uses of plastics in manufacture through discussions with sales representatives at the companies listed in this Section. Plastic fasteners are used by a wide range of industries, including:

- Aerospace
- Automotive
- Chemical
- Construction
- Electronics
- Furniture
- Medical
- Semiconductor
- Telecommunications

The above list includes all the different industries that came up in these interviews. Industries mentioned more prominently included:

- Automotive
- Electronics
- Medical

Internet Scan of Commonly Used Materials

Following are several of the more commonly used materials employed in the manufacture of plastic fasteners.

Nylon 6/6. Characteristics: This material possesses a high degree of resiliency and fatigue strength. It has high impact and abrasion resistance. Nevertheless, it has a relatively high water absorption characteristic and weathering can cause it to become brittle. Uses: Nylon 6/6 is used in gears, bearings, nuts, bolts, rivets, power tool casings, and fan blades.

Polyvinylchloride. Characteristics: This material, also known as PVC, exhibits little to no water absorption, regardless of its exposure or use. Chlorinating PVC has many of the same properties as PVC, but it also provides increased fire retardance and weatherability. Uses: PVC is used in hoses, tubing, seals, gaskets, bottles, and wall coverings.

Polychlorotrifluoroethylene. Characteristics: This material, also known as PCTFE, is nonflammable and has near zero moisture absorption. Over a wide temperature range, it scores highly in terms of compression, impact, and tensile strength. Uses: PCTFE is used in valve seats, seals, gaskets, laboratory equipment, medical equipment, gears, cams, and bearings.

Polyetheretherketone. Characteristics: This material, commonly referred to as PEEK, is regarded to be tough and strong with very impressive fire ratings. PEEK can also be glass-filled, giving it high strength, stiffness, and stability. The glass-filled grade works well in structural applications. Uses: PEEK is used in bearings, piston parts, pumps, and compressor plate valves.

Ryton PPS. Characteristics: This material is regarded as exceptionally strong and resistant to corrosion. It has been found to retain its structural integrity under demanding conditions and outright physical abuse. It is naturally flame retardant. Uses: Ryton PPS is used in coolant, fuel, braking, transmission, and engine parts of automobiles. It is also used in pump and motor parts in industrial applications.

Ultra High Molecular Weight Polyethylene. Characteristics: This material, known as UHMW for short, is a very safe and commonly used material. It has a high resistance to stress and cracking. UHMW is able to maintain its integrity under high stress and impact situations. It is easy to produce and is considered an economical material. Uses: UHMW is used in civil engineering and earth moving equipment, truck trays, bins, hoppers, a variety of manufacturing equipment, and bulk material handling.

ULTEM 1000. Characteristics: ULTEM 1000 is a naturally flame retardant material, with a number of high performance properties. It has been found to be the ideal replacement for steel and other metals. Uses: ULTEM 1000 is used in interior components of aircraft, buses, and other vehicles, as well as various pump and valve parts.

Based on the brief descriptions (above) associated with a particular material's characteristics, it is clear that each of these plastics has been engineered to perform at a high level while withstanding harsh conditions. Features such as flame retardance, high impact strength, low water absorption, and high tensile strength are features whose use could be applicable to a residential construction application.

Furthermore, materials that serve as substitutes to metal products are particularly encouraging for potential use in a construction application. It appears there are a number of materials that could be promising in the future development of a plastic fastener for the intended application.

Internet Scan of Manufacturers' Websites

Websites of the following manufacturers were scanned in order to determine the availability of existing plastic fasteners.

- Craftech Industries, Inc.
- EFC International
- ITW Fastex
- Utility Composites, Inc
- Volt Industrial Plastics

Newport's review of the products on each of these sites identified no plastic fasteners whose use was explicitly stated to be for a residential construction application. Newport then began a search for any products that were not displayed on the website, or for an existing product serving an alternative function that possibly could be used or modified and then used — to attach siding through insulation to a metal structure in residential construction. This task required an email or phone interview with a qualified representative from each of the manufacturers (see Figure 8).

Figure 8 presents the company name, location, a brief description, and the website address of the companies for which Newport scanned its website and interviewed a representative.

Figure 8 . Companies Interviewed for This Project

Company	Location	Description	Website
Craftech Industries, Inc.	Craftech Industries, Inc. 8 Dock Street PO Box 636 Hudson, NY 12534	Craftech is a high-technology manufacturer that serves a variety of industries including the semiconductor, aerospace, medical, telecommunications, chemical, electronics, marine, automotive and waste management industries. Their diverse manufacturing capabilities include injection molding, mold building, screw machining and CNC machining.	http://www.craftechind.com
EFC International	EFC International Corporate Headquarters 1940 Craigshire St. Louis, MO 63146-4008	EFC International is a provider of the most comprehensive line of performance enhancing, cost-effective specialty component parts. These parts include clamps, panel fasteners, nut -type fasteners, plastic clamps and clips, and male threaded fastener, among many others.	http://www.efc-intl.com
ITW Fastex	ITW Fastex® - U.S. 195 Algonquin Road, Des Plaines, IL 60016	ITW Fastex is a division of Illinois Tool Works, a Fortune 200 company focused on material and process technologies. ITW Fastex is a plastic manufacturer and developer. It offers a range of products to address a number of different applications and industries.	http://www.itw-fastex.com
Utility Composites, Inc.	Utility Composites, Inc. 2704A Meister Place	Utility Composites Intl, Ltd manufactures and sells RAPTOR® engineered polymer	http://www.raptornails.com

Company	Location	Description	Website
	Round Rock, TX 78664	nails and staples. RAPTOR® nails and staples are patented fasteners. They are high strength polymer composite nails and staples (completely non-metal) for pneumatic nailers, and pneumatic and manual staplers.	
Volt Industrial Plastics	Volt Industrial Plastics 80 Industry Lane Flippin, AR 72634	Volt Industrial Plastics' subsidiary JV Tool, can design and produce unique plastic fasteners and injection molded parts. Their catalog contains a number of polymers, co-polymers, and resins that are used to manufacture precision plastic fasteners.	http://www.voltplastics.com

Telephone Interviews

The following paragraphs present summaries of phone interviews with qualified manufacturer representatives. Each summary (1) states whether or not the manufacturer produces a specific fastener for the intended application; (2) details the representative's recommendation; and (3) provides a rationale for this alternative and for an alternative fastener that the manufacturer does produce, if applicable.

Craftech Industries, Inc. Product: A representative from Craftech stated that they do not manufacture a specific product for this application. Recommendation: The type of material this representative would recommend as a fastener would be an Isoplast (a very tough stable urethane resin) or some type of glass-filled nylon.

Rationale: The Isoplast could be a viable option because of its strength and noted ability to withstand weather conditions. The Isoplast material exhibits a high tensile strength and is available in long glass-filled grades. Test results found high toughness and dimensional stability. Similar to the ULTEM 1000 material, Isoplasts are used to replace metal in applications where there is a load-bearing weight.

EFC International. Product: Newport asked a representative from EFC if they produced any plastic fasteners that were specifically for residential construction applications. She stated that they did not, but many of their fasteners have a wide range of applications. Recommendation: Newport described the intended application for the fastener and the representative stated that she would suggest a product from within EFC's panel fasteners.

Rationale: This recommendation was due to the fact that these panel fasteners are typically used to fasten two or more separate pieces together. She stated that most of EFC's fasteners are made out of a variation of the Nylon 6/6 material. It was suggested that a dart type panel fastener, such as a Christmas tree clip, should be used. The representative advised that a metal-rivet-type fastener be used if we intended to secure the fastener into a metal stud. She did not believe that any of the company's plastic fasteners would be able to penetrate a metal stud.

ITW Fastex. Product: Newport spoke with a representative from ITW Fastex. He stated that ITW does not manufacture any fasteners with the requisite length to attach siding through 2 to 3 inches of insulation to the frame of a structure.

Recommendation: The representative suggested that an existing product could be modified for this application. He also pointed out that he would anticipate using a PEEK material for the fastener.

Rationale: In the preceding pages, PEEK was noted to be available as glass or non-glass-filled and is known for its high strength and stiffness. Still, this representative was concerned that the extended length that would be needed might compromise the fastener's ability to handle the combined weight of the insulation and siding. In response to a similar question about added length affecting the fastener's load-bearing ability, a different ITW Fastex representative stated that he does not know of any plastic fasteners that are used in load-bearing capacities for construction applications. He mentioned that only metal fasteners would be used in this scenario.

Utility Composites, Inc. Product: Newport discussed the RAPTOR products with their manufacturer, Utility Composites, Inc. The RAPTOR products include composite nails and staples. The representative said that she doubted that the RAPTOR products would penetrate metal studs. In addition, the representative stated that the RAPTOR nails have a lower shear strength than metal nails. Recommendation: This representative did not offer a recommendation for an alternative product, as Utility Composites, Inc. does not manufacture or sell any products outside their RAPTOR brand.

Rationale: It was noted that the RAPTOR products are more expensive than metal fasteners, which restricts RAPTOR use as an alternative to metal, unless there is some sort of a problem with the metal fasteners.

Volt Plastics. Product: Newport spoke with a representative from Volt Plastics. When she learned the intended use of the product, she explained that Volt does not manufacture a product specifically for that application. Recommendation: The representative suggested a Christmas tree clip, a push-in fastener, or a canoe clip.

Rationale: These fasteners were recommended because of their length. The fastener is composed of Nylon 6/6 material.

Three points relative to the interviews Newport conducted with company representatives are worth discussing in more detail. First, none of the representatives stated that their plastic fasteners would be able to penetrate a metal stud. The fasteners that were recommended as alternatives were singled out because of their ability to satisfy other requirements of the intended application.

Second, while there was relatively low confidence in the RAPTOR nail's ability to penetrate a metal stud, there was interest in testing the product in this application. Testing the product in this situation could possibly yield information that would be valuable to subsequent research and development activities or to the actual commercialization of a finished product.

Finally, in a follow-up conversation with ITW Fastex, a different company representative concurred that the company does not manufacture a plastic fastener of a requisite length for the intended application. He said that all their fasteners are made using an injection mold process and they do not have an existing mold that would produce a fastener long enough. As a result, they would have to create a mold. He explained that this is a very expensive process and a substantial minimum volume would be required in order to absorb this cost on a per unit basis.

REVIEW OF RESEARCH LITERATURE

Newport performed a review of the National Science Foundation (NSF) literature, to identify any current or relatively recent research being conducted on plastic materials. There was no relevant information found under the Discoveries heading. Still, under the News heading, Newport identified two stories of interest. Each project was funded by NSF and was announced within the past year.

The first relevant research article (University of Oregon, 2008) involves a new theory of motion in polymers that may lead to the reduction of costly and time-consuming testing of samples at the various stages of the material's production. This study enables those who manufacture the material to have greater control over its properties. In turn, this will allow for more exact results in the synthesis of these materials.

Interpretation: More exact results will mean less waste. This, in turn could lead to more efficient production methods that could reduce the overall cost of production.

The next research item (Sakai, 2008) reports on research striving to gain a better understanding of why plastics are so tough and whether these materials will retain this property over time, despite significant stress and strain within a current application. A unique molecular arrangement is what gives plastic its ability to flow — or bend — rather than break. This study provided new insight into the molecular arrangement. Research in this area is important because the use of plastics in place of metal is becoming more and more prevalent — for instance, the Boeing 787 will have five times the proportion of lightweight polymer materials to metal than the Bowing 777 had. Thus, as these materials are used in applications where any failure would bring significant consequences, it is important that it is understood how these materials will react under continuous stress over a long period of time.

Interpretation: As plastic materials become more dynamic, they are used in applications where their proper functioning is critical. New understanding why these materials are so durable and what effect stress and strain have on them over time could lead to the development of plastics that are even stronger over a longer or more predictable period of time.

Newport searched *Reinforced Plastics*, an online magazine serving as a comprehensive source of information for the composites industry. In the Construction section, two recent articles were worth noting (Reinforced Plastics, 2009a: and Reinforced Plastics, 2009b). Interplastic Corporation has launched a line of vinyl ester resins for composite applications that are fire retardant and corrosion resistant. It was noted that specific products within the line are designed for construction applications.

Interpretation: The ability to resist corrosion is a characteristic that increases the weatherability of a material. This is an important attribute for an exterior fastener.

The National Institute of Standards and Technology and France's National Scientific and Technological Institute have joined forces to study the potential for fiber reinforced plastic (FRP) composites to be used in high-strength applications. Part of this project will be to test the long-term weathering effects on advanced composite materials. The weathering effects include UV radiation, temperature, and humidity and how they can affect a material's service life.

Interpretation: Interest in FRP composites use in high-strength applications is illustrative of the material's potential to perform effectively in load-bearing applications. A better understanding of how weathering affects the material's service life could shed light on how to further immunize these materials from the effects of serving in an exterior environment.

REMAINING ISSUES

In order to bring plastic fasteners to market, it would be necessary to overcome two issues: (1) the difficulty of penetrating a metal stud with plastic fasteners and (2) the substantial cost of developing molds for new products.

Plastic fasteners are either unable or would have a difficult time penetrating a metal stud. Several of the interviewed representatives confirmed this fact. Alternatively, plastic fasteners do show promise for use in soft materials, especially when fasteners have a broad bearing surface.

In an article by Bluemay International, a London-based manufacturer of nylon threaded moldings, it was noted that most fasteners are produced from a wide range of standard-sized molds that allow them to be made cheaply, quickly, and in large quantities. Nevertheless, if the fastener is required to be of a length not associated with a mold, its production cost may become higher, since a new mold must be created. This is especially true if quantities initially demanded are not large enough to produce sufficient economies of scale. The interviewed representative from ITW Fastex supported this point.

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SECTION 3 - CONSTRUCTABILITY ISSUES

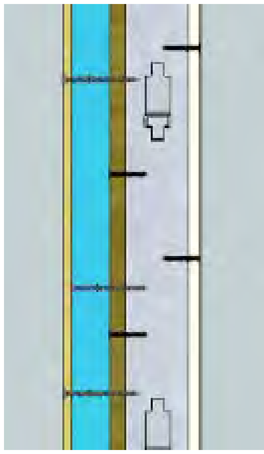
Each time a building code or building technique changes, builders must adapt and overcome any construction issues that may arise. Often, solutions go through several stages before builders can identify an acceptable and efficient resolution. This was the case when building codes began to require more insulation within the wall cavities. Builders adapted by increasing the wall width to 2x6 instead of 2x4 the norm at the time. (See Figures 9 and 10.) Consequently, they also had to adjust window and door jambs in order to keep them flush with the finished wall. On-site window/door jamb extensions had to be built until the window and door manufacturers started offering factory-built extended jambs.

Figure 9. Home in New York Covered with 2" of Rigid Foam

The use of rigid foam insulation to depths of up to one inch does not generally create significant concerns for most buildings. Even so, the use of more than one inch of foam (two inches, three inches, and four inches of rigid foam and beyond) can lead to a number of constructability issues that need to be addressed during the early stages of the design process as well as during construction. It is important to address these issues so that builders understand proper application techniques of cladding and other outer shell items.

It can be difficult to anticipate all of the possible constructability issues that may arise while installing different types of cladding (vinyl, fiber cement, wood lap, brick/stone veneer, solid brick, and stucco) over continuous insulation up to four inches thick. Newport Ventures conducted an assessment of the proposed solutions identified in Section 1 of this report to identify constructability problems and solutions. During the course of this investigation, Newport carried out a thorough review of manufacturer literature; drew upon their own professional and technical knowledge; spoke with experts in the carpentry, electrical, plumbing, and HVAC trades; and visited numerous construction sites to create a complete list of constructability issues. Much of the experience with using foam insulation that is thicker than one inch on exterior walls is limited to lower rise buildings, such as housing. Thus, although the findings of this task may reveal a slight bias toward housing construction practices, much of this experience can be extrapolated to larger buildings.

Figure 10. Sectional View of a Steel Framed Wall with Continuous Rigid Foam



CONTRACTOR SESSION

As part of the assessment, Newport also conducted a face-to-face, hands-on, discussion group with contractors to explore issues related to the use of thicker rigid foam applications on the exterior of a steel-framed wall. The session focused on extended length fasteners, other fastening needs, and the interaction of the foam with different structural features and external claddings.

The purpose of the contractor's discussion group was to examine constructability issues that may arise with the attachment of up to four inches of rigid foam insulation to the exterior side of a steel-framed wall, as well as to test the theories and solutions identified in the first stages of research. (For more information about the meeting, see Appendix A to Section 3: "Discussion Guide for the Contractor Session," at the end of this Section.) The meeting occurred January 6, 2010 at Newport Ventures, Schenectady, New York office complex.

Four contractors were invited to provide insight and to gain useful feedback on issues that may arise during field applications of continuous installation. The group consisted of a carpenter, electrician, plumber, and an HVAC contractor.

To facilitate discussion, Newport constructed a full-sized model of a steel-framed exterior wall (see Figure 11), which had sections 8- feet in length and 8- feet tall and incorporated both inside and outside exterior corners, allowing room for fastening a variety of trim and siding materials. The model included a doorway and a window opening, although actual windows and doors were not installed.

Figure 11. Full-size Model of Exterior Wall

The model process provided a helpful, hands-on means of demonstrating different assembly aspects as they relate to on-the-job issues that may occur with the use of added continuous rigid foam insulation. The model displayed multiple assembly options, allowing contractors to view the inside of the wall cavity in order to examine screw penetration and other aspects of the construction.

Results of Contractor Session

The main concern that the contractors raised was that some of the longer fasteners are not available from local suppliers. Construction delays, however, can be avoided by identifying the proper fasteners early on, ordering them directly from manufacturers, and having them delivered directly to the job site.

Another significant issue that contractors mentioned was the ability to maintain production speed as the structure is being built. Changes to the home's outer shell, such as greater depth of rigid insulation, can slow this process. Builders use nail guns for quick and efficient installation of some cladding materials, but the fasteners used in nail guns are limited to 3 ½ inches in length. This limit essentially restricts the use of air guns once the thickness of the rigid insulation reaches the point where fasteners longer than 3 ½ inches are required. As a result, the effort required for a task such as siding fastening may shift from only requiring one carpenter to now requiring two. For instance, where previously one carpenter could hold the siding with one hand and hold the nail gun pressed up against the siding in the other, now one hand must hold the screw to the tip of the screw gun, another must hold the screw gun itself, and at least a third hand is needed to hold the siding in place. Thus two carpenters are required for a task which previously required one. Unlike some new building techniques where the initial impact on labor time is only temporary, contractors did not anticipate that this impact on labor requirements would decrease even as they become more familiar with the process. The installation of siding over thicker foam panels will require more than one person for the foreseeable future and estimates of total project costs must take account of this production impact. Follow-up questions and answers were obtained from phone and email communications, as contractors were asked to think more about possible issues arising in attaching different siding types, such as fiber cement, vinyl, or stucco.

Along with prior research findings, the information gathered from the contractors was used to identify specific constructability issues, as Figure 12 shows. The table then provides suggested solutions, intended to account for structural and performance concerns, reduce site construction time, and minimize impromptu solutions that may differ from builder to builder. Fuller discussions of these solutions follow the figure.

Figure 12. Constructability Issues

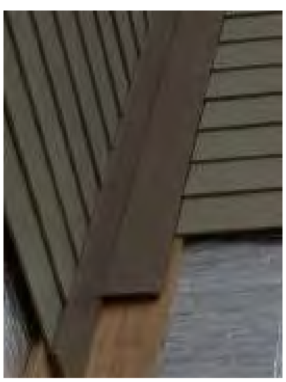
Constructability Issues	*Concerns*	*Solution #1*	*Solution #2*	*Solution #3*
Blind connection of fasteners to steel studs	Fasteners securing to the steel studs.	Transfer layout directly from wall framing to each attachment of rigid foam insulation.	Snap vertical chalk lines at each stud location after foam has been installed.	
Outside/Inside Corners	Fastening trim detail to the building.	½" or ¾" plywood ripped to proper width, depending on the thickness of the foam used.	Aluminum flat stock bent 90 degrees screw to metal studs.	
Windows/Door Jambs	Fastening windows/doors to the exterior of building.	Solid lumber or plywood box attached back to wall framing (bucks). Openings should be wrapped with adhesive flashing.	Extended widow and door jambs to fit additional width of wall opening.	Metal Strapping/Brick Ties
Below Grade Wall Transition to Above Grade Wall	Exposed rigid foam on the exterior of the building. Break in thermal envelope.	Cap rigid foam with metal flashing. Metal flashing can be attached to the front of the foam before siding is attached and attached back directly to the foundation.	Continue rigid foam insulation from AGW to BGW flush.	
Gable End Transition	Finished appearance/ aesthetics.	Continue rigid foam full length.	Frame out gable end wall with studs to flush up with rigid foam.	
Roof/Soffit/Wall Transition	Finished appearance/ aesthetics. Break in thermal envelope.	Adjust preliminary drawings to reflect added rigid foam insulation.	Raised Heel Truss to allow for insulation to meet attic insulation levels and for the attic insulation to extend flush with rigid foam on the wall.	Accept reduced overhang as is.
Decks	Solid fastening of deck to the house.	Bolt solid wood blocking back to exterior wall. Avoid a built up solid ledger as this	Provide footings for deck along the house to keep deck separate from house.	

Constructability Issues	Concerns	Solution #1	Solution #2	Solution #3
		would create a thermal break.		
Peripherals				
Dryer vent, hose bib, direct vent appliances, doorbell, flower box, brackets, etc. (Not seen as major issues)	Solid attachment	Longer fastening screws to attach item to sheathing or stud. J-Blocks can be installed as well with a longer fastener.	Add in solid blocking at the location of the peripheral item.	

Blind Connection of Fasteners to Steel Studs. The first issue that arises from covering up the sheathing on a home is the visual loss of the stud layout. This applies to any sheathing regardless of the thickness and may not be new to many builders. No longer can the carpenter see where the studs are located on the wall. This is important, as many cladding manufacturer warranties require their product to be fastened directly to the framing. Builders can overcome the visual loss by transferring marks directly to the foam board as it is applied sequentially up the face of the wall. Another option is measuring over the rigid foam and placing marks to later snap a chalk line. Both options increase installation time, but will ensure that the fasteners penetrate into the steel stud.

Outside/Inside Corners. The added thickness of rigid foam can create issues when fastening foam and siding at the corners of a building (see Figure 13). On outside corners, the closest stud will be as much as four inches off of the corner, leaving no suitable way to secure a fastener. To address this problem, furring strips, plywood, OSB, metal corners, or other suitable material can be applied over the corners to create a permanent attachment surface. The materials must be wide enough to enable carpenters to secure them to the closest stud. Metal may prove to be the most practical material because its relative thinness compared to wood and other materials eliminates a potential problem of a change in the surface at corners. With thicker materials, some builders have also used wood or plywood on inside corners to eliminate the change in surface. Intermediate furring between the inside and outside corners may also be necessary if using thick corner materials.

Figure 13. Sliding Plywood at Inside and Outside Corners



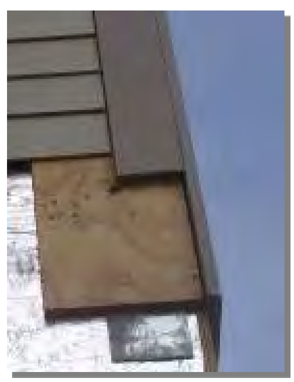


Figure 14. Extension Jambs Attached Directly to a Window

On inside corners, the foam on an adjacent section of wall must stop short of the end of the wall to allow room to attach corner studs in the intersecting walls. It is especially important to account for this factor if the foam is added before the walls are tilted up into place. Further, carpenters will need to place an extra stud in the wall cavity 4 to 6 inches from the inside corner to provide a surface for attaching the foam and siding.

Window/Door Jams. Using thick layers of rigid foam board causes the exterior wall to be much thicker than a conventional wall, creating a deeper-than-normal window and door opening (see Figure 14). The flange mounted on most windows is used to connect to a solid surface such as a stud. It cannot be secured to foam. Additional framing, such as a wider stud, can be used to box out openings and provide a solid surface for attaching windows and doors. Using this option will require extended window and door jambs to compensate for the additional wall thickness, or drywall returns on the inside. Another option is to mount the windows to the wall before the rigid foam is added. This will create a recessed window pocket that will need to be flashed and sealed properly to prevent any leaks. One drawback to this option is that recessed windows are not a common look for many buildings. This option also changes the traditional sequence of construction. This may be particularly difficult for panelized construction if the panel manufacturer is charged with providing panels already sheathed with foam.

Below Grade Wall Transition to Above Grade Wall. The transition from the foundation to the above grade wall is an area where the additional rigid foam board will need to be detailed (see Figure 15). This detail creates an exposed area at the bottom of the wall that should be covered to protect the foam.

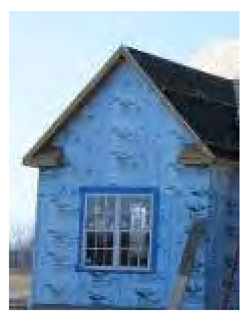
One option would be to cap the foam at the bottom of the wall with metal flashing. This metal flashing can be secured to the foundation and the exterior wall by using common fasteners. Another option is to continue the rigid foam down to the ground level to create a smooth transition from the above grade wall to the foundation. The advantage to this method is creating an insulated foundation wall from the outside. It will, however, require a parge/stucco coating to protect the foam from sudden impacts such as from a lawnmower or a weed whacker. A disadvantage of this option is that it conceals termite tunnels.

Figure 15. Capped Foam Edge at the Bottom of a Wall with Metal Flashing

Gable End Transition. The gable ends of a house with an unconditioned attic space do not require the rigid foam board that would be in place on the rest of the building. This option, however, would not allow for a smooth transition between conditioned space and unconditioned space on the exterior wall. One option (see Figure 16) to alleviate this concern is to run the rigid foam board completely to the roof line. Fiberboard or other alternative sheathing materials may be less expensive than foam for the gable end section of the wall.

Figure 16. Rigid Foam Applied to Gable End on the Ground than Lifted into Place with a Crane

Figure 17. Rigid Foam Continued over Gable End



A second option (see Figure 17) is to build the gable end so that the OSB or other sheathing lines up with the foam sheathing to eliminate any transition. This option will likely be more practical with thinner foam insulation. The gable end cannot be offset more than an inch or two, or there will not be a way to attach it to the wall below. As a third alternative, it may be possible to fur -out the gable end.

Roof/Soffit/Wall Transition. The addition of rigid foam reduces the roof overhang and the soffit area. If it is important to maintain specific dimensions for aesthetic reasons, the length of the overhang should be increased during the design of the building.

Decks. Decks are often attached through a continuous ledger board adhered to the structural frame of the building. When foam is introduced, it is important to maintain the structural integrity of the ledger board's connection to the wall. If the ledger is to be placed over the foam, a qualified professional should design the fastenings and the code official should approve them. Another option is to cut the foam out, attach the ledger board to the structure, and then install foam between the bays of the joists of the deck. This option will minimize the surface area that can produce thermal bridging and allow the continued use of the traditional ledger board method. A third option for low-rise buildings is to build the deck as a stand-alone structure, not secured to the house at all. There are trade-offs to each of these options, including significant extra costs for some.

Peripherals. Additional items , while not major concerns, but should receive attention, are peripheral matters such as dryer vents, hose bibs, direct vent appliance, doorbells, flower box, and brackets. To properly attach these peripheral items to exterior walls will require blocking, longer fasteners, or extensions.

The solutions for attaching siding identified in Section 1 include direct attachment to studs through foam, attachment through foam to structural sheathing, or connecting siding to steel hat channels or wood furring strips installed over the foam. It is important to note that the hat channel or furring strip approach solves at least a couple of the issues that were identified in Constructability Issues, Figure 12. For example, if a hat channel is used, it can be extended to the end of the wall at outside corners to provide a fastening surface for siding without the need for a special corner. A hat channel can also provide a surface for attaching periphery items to walls with thick foam insulation.

COORDINATING FINDINGS

One of the primary objectives of this project is the evaluation of specific fastener types for use with the proposed solutions for attaching siding when foam up to four inches thick is used on exterior walls. This includes the development of specific language acceptable for building codes.

Sections 3 and 4 are somewhat inter-related in that laboratory testing and analysis described in Section 4 revealed several constructability issues:

Overall, the findings of this section seem to confirm that the direct attachment to studs and the hat channel/furring method offer technically justified solutions. Some specific findings related to these solutions are as follows:

1. It is important to order specialty screws (i.e., extra long length) for siding-to-steel connections well ahead of time in the construction schedule (even stock up if you have more than one construction project planned). The laboratory had trouble finding fasteners of adequate length for the four-inch-thick foam assemblies. The five-inch fasteners that were originally ordered were long enough but the threaded section of the screw was not. The lab was eventually able to find a bugle head screw that did have the right length with a threaded length long enough to engage the studs. Although these screws were adequate for the testing, they may present problems for finishes or could damage hat channels when installed. Because of time constraints involved in waiting for the screws, the testing did proceed with the original screws on the wood furring application. Notwithstanding, it was necessary to reduce the wood furring to 3/8 inches thick. This resulted in more conservative fastener requirements than if the thicker 3/4 inch furring had been used for the four- inch foam assemblies. It may be that, until such time as appropriate fasteners are more widely available, assemblies with more than 3 to 3 1/2 inches of foam represent the practical limit on exterior continuous insulation.
2. The torque setting on the screw driver needs to be set to ensure that connected parts are adequately compressed together without any gaps, yet also without the over-tightening that could damage siding or furring materials.
3. Where possible and depending on the type of siding used, use wing-tipped, self-drilling/tapping screws to prevent the fastener threads from engaging in the connected parts, causing separation of the foam sheathing and furring/siding from the steel framing.

More research is needed to further assess the advantages and disadvantages of attachment directly into OSB or other structural sheathing. It is unlikely that we will be able to rely on connection to wood sheathing materials to support heavy siding materials (e.g., greater than 3 psf) with an intervening layer of foam sheathing. Based on limited testing, these connections are subject to much greater creep (long-term movement) than with the use of direct connection to steel framing. Also, when using fasteners of greater diameter than 0.120 inches, there appears to be a negative impact on withdrawal capacity due to break-out of wood fiber/chips on the back side of sheathing. For the time being, the language for code adoption discussed in Section 4 will not include the solutions that include direct attachment to sheathing.

APPENDIX A TO SECTION 3 - DISCUSSION GUIDE FROM THE CONTRACTOR SESSION

1. Introductions and ground rules (two minutes)
    a. Introductions – Name, company, what you do
    b. Ground rules – Don't be afraid to give your opinion, work for equal speaking opportunity for everyone.
2. Explanation of the overall issue – (two minutes on the issue, the siding types, the wall, etc.,)
3. Brainstorming Session (general guidance of average of five minutes an issue)
    a. Ask participants what immediate issues come to mind when trying to attach the following sidings over up to four inches of foam insulation – vinyl siding, fiber cement, wood lap, stone/brick veneer, anchored stone/brick, and stucco.
    b. For each issue, ask for suggestions of possible solutions.
    c. For any issues already identified in our list, after discussing their solutions, ask: "what do you think of [solution x]?" Will it work? Is the issue solved or is it still a problem even if that solution helps.
    d. Ask if any suggested solutions could be combined to come up with a complete solution or are they standalone solutions.
4. After brainstorming session, continue through the list of identified issues following the same format as above. (again, general guidance of five minutes an issue). See Example Questions below:
    a. How would you handle the fastening trim detail for siding on the outside corner?
    b. Would ½" or ¾" plywood ripped to the proper width work? How about aluminum flat stock bent 90 degrees and screwed to the stud?
5. Ask if any additional issues have come to mind after going through that list.

SECTION 4 - A PRESCRIPTIVE TABLE OF FASTENERS FOR ATTACHING CLADDING TO FRAMING OVER CONTUNUOUS INSULATION AND DEVELOPMENT OF A CODE PROPOSAL

Recent and ongoing changes in model energy codes intended to improve energy efficiency of buildings have created an urgent need to address technological gaps in methods of attaching cladding to steel-framed wall assemblies, using various thicknesses of continuous insulation (foam sheathing), to the wall assembly. The U.S. model building code is currently considering solutions to address this need. Similar solutions also are needed for cold-formed steel-framed wall assemblies.

It is expected that, in the near future, model building codes and standards will require a much more extensive use of foam sheathing on steel-framed wall assemblies. The required thickness of foam sheathing may vary from 1- inch to 4-inches, depending on the type of foam sheathing used and the climate, among other considerations. Such requirements necessitate rational and practical solutions for attachment of cladding to walls through a potentially thick layer of foam sheathing. These solutions must also provide safe and serviceable methods of installing cladding and continuous insulation.

The purpose of this task of the NYSERDA/SFA project was to identify prescriptive requirements for fasteners in attaching cladding to steel framing. Multiple scenarios were to be evaluated, including synthetic stucco, fiber-cement, wood, and vinyl siding, applied over various thicknesses of foam. The outcome was to be a prescriptive-based set of requirements for fastening siding that could be incorporated into building codes.

A multifaceted set of activities was necessary to address the objectives, involving several research and development steps as follows:

1. Consideration and application of precedents for performance criteria and building code requirements related to cladding connections, as identified in Sections 1 and 3.
2. Development of viable connection strategies in coordination with constructability issues indentified in Section 3.
3. Assessment of methods for developing fastener requirements based on accepted engineering practices. (Based on early findings, this activity was expanded to include preparation of a test plan to resolve technological gaps in understanding and predicting the performance of cladding connections to steel framing with an intervening layer of continuous insulation).
4. Execution of the test plan with adjustments to respond opportunistically as “real-time” findings revealed new information.
5. Analysis of test results to develop a rational means of predicting connection performance for a variety of conditions or cladding assembly variables addressed by the test plan, including coordination with research, testing, and analysis methods being developed by others,
6. Preparation of building code proposals to implement and integrate findings within the context of current model building code provisions for siding attachment and foam sheathing.

This task report documents the outcome of these activities. First, a background section reviews the various siding connection strategies considered for this effort. Second, a technical approach section presents an overview of research and testing plans. A summary of testing results follows. Next, an analysis of results discloses the evaluation of test data to derive or confirm rationalized design methodologies for calculating cladding connection performance when the fastener must span through an intervening layer of foam sheathing. This design methodology, together with building code performance requirements, was used to derive a proposal for ICC building codes for fastening of siding through a layer of continuous insulation. Then, conclusions and recommendations are presented. Three appendices provide supplementary information including:

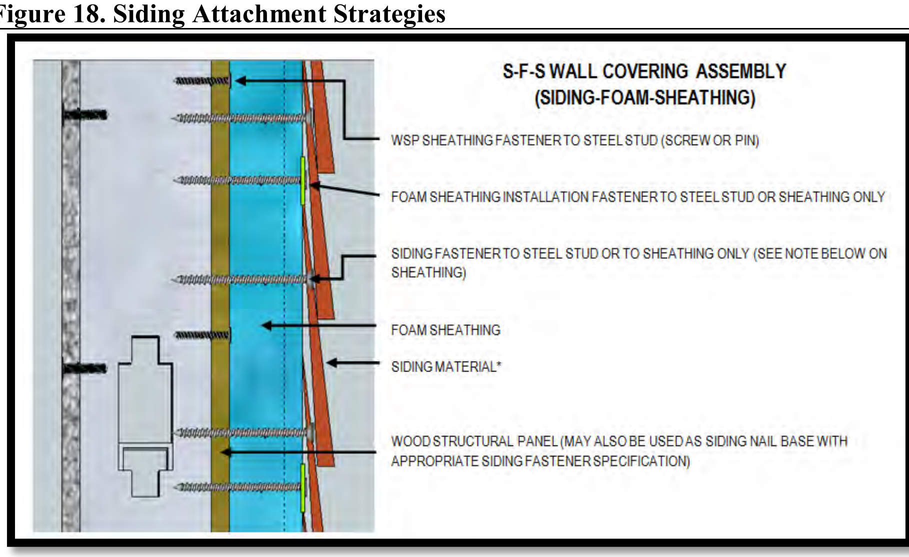
- Appendix A. Analysis of Cladding Connections.
- Appendix B. ICC Model Building Code Proposals for 2012 IBC and IRC.
- Appendix C. Test Lab Report (PEI, 2010A).

BACKGROUND

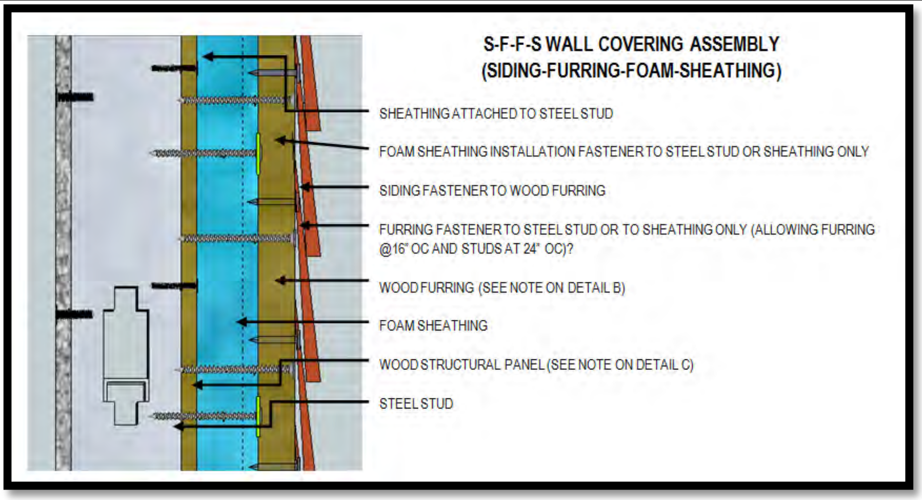
Among various possibilities, researchers identified four cladding connection strategies for consideration. These strategies, shown in Figure 18, may be described as follows:

1. Attachment of cladding to a sheathing fastener base (Option #1) located behind the foam sheathing by way of a direct siding condition (Means (a) or by way of a steel or wood furring member (Means (b)).
2. Attachment of cladding to a framing member (Option #2), again by way of a direct siding connection (Means (a)) or by way of a steel or wood furring member (Means (b)).

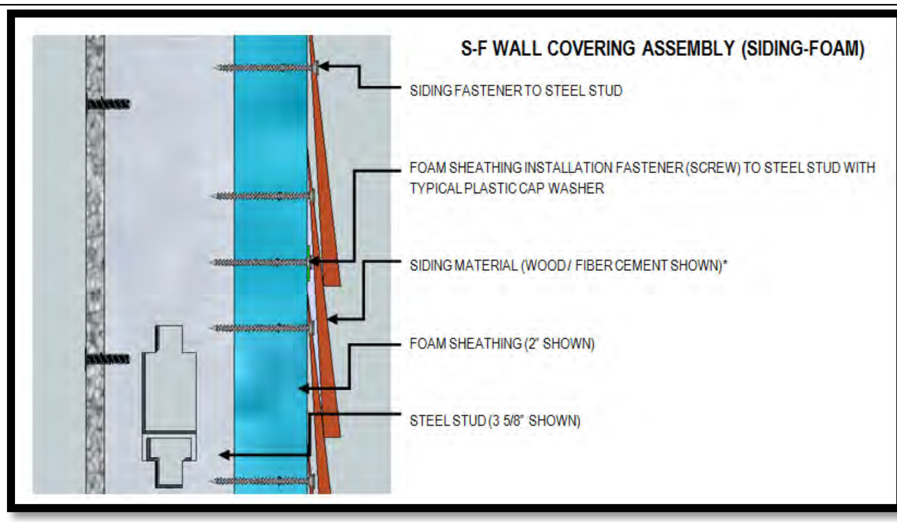
Figure 18. Siding Attachment Strategies



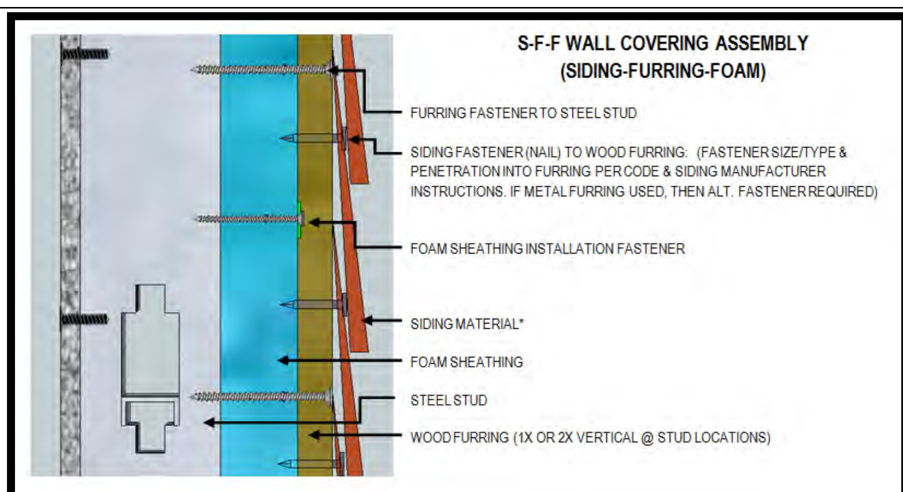
Option #1, Means (a) – Siding to Sheathing



Option #1, Means (b) – Furring to Sheathing



Option #2, Means (a) – Siding to Stud



Option #2, Means (b) – Furring to Stud

The paragraphs that follow address structural requirements for the four siding attachment strategies shown in Figure 18 by testing and analysis to ensure capability to:

1. Adequately support siding dead load (i.e., transfer shear forces from siding weight through a thickness of foam sheathing into the structural framing members or sheathing), and
2. Resist wind pressure and seismic forces[3] (i.e., transfer out-of-plane forces from wind pressure or seismic accelerations acting on siding through connections and into the structural framing members or sheathing).

While the details in Figure 18 indicate a lapped type of siding, various siding types may be applied with identification of a siding fastener with appropriate diameter and head shape/size compatible with the siding manufacturer's installation instructions and building code requirements. Where wood furring or steel hat channels are used, builders may apply typical siding fasteners. This report focuses mainly on how to attach the furring or hat channel over foam sheathing to support the siding. For direct cladding attachment over foam sheathing to steel framing using self-drilling tapping screws, availability of "extra-long" fasteners was faced with some supply problems caused by low demand in current market conditions. Still, using the strategies described earlier, fasteners (manufactured by Grabber) allowed up to four inches of foam sheathing thickness. Other fasteners for steel and wood connections were identified through common distributors such as Fastenal. For direct attachment to a base sheathing such as OSB, various fasteners may be used to make this connection (i.e., screws or nails) that are generally available in a reasonable variety of non-standard (extra-long) lengths. For example, a 6-inch-long "foundry nail" of 0.135-inch diameter was readily available (manufactured by Maze Nails). Nevertheless, this research identified some concern with creep (long-term movement or settling of the connection) with connections made directly to sheathing. This concern is addressed later, based on results of testing.

Finally, this project does not address cladding materials designed to be separately supported, such as brick veneer. These materials may be attached to continuously insulated walls without concern for the fastening needing to support the weight of the cladding. Thus, the connection need only resist the out-of-plane forces from wind or seismic actions. These cladding connection solutions are readily available with or without continuous insulation on wall assemblies and can be designed with existing technology.

TECHNICAL APPROACH

Once completing the background investigation, researchers developed a comprehensive research plan to provide a means of characterizing and predicting the performance of connections similar to those shown in Figure 18. When available, existing engineering knowledge was used to predict connection capacities and a test plan was developed to verify the ability to make accurate predictions of actual performance.

Researchers found that existing knowledge regarding this type of connection (with a gap between the connect parts occupied by a material like foam insulation) was limited to a wood-to-wood or steel-to-wood connection design theory,

[3] Seismic forces are mainly a concern for heavy siding materials.

known as the National Design Specification for Wood Construction (NDS) or European Yield Theory for wood connections resisting shear loads (AF&PA/NDS, 2005; USDA/FPL, 1986(a)). This design theory has the capability of estimating connection shear strength when connections have a gap or an intervening layer of foam sheathing (AF&PA/TR-12, 1999). In fact, the "gap parameter" as used with this design theory was developed by the U.S. Department of Agriculture (USDA) Forest Products Laboratory based on limited testing of wood-to-wood connections with an intervening layer of foam sheathing up to one inch thick (USDA/FPL, 1986(b)). The method has also been generalized for use with a variety of other materials (such as concrete or steel), but only for specific configurations for connections to wood members (AF&PA/TR-12, 1999). Unfortunately, a similar mechanics-based design theory for steel-to-steel and wood-to-steel connections (or various other materials to steel) does not exist for connections with or without a gap between the connected parts. Instead, equations used for the design of these types of connections are aimed at connecting steel parts only, relying on empirical relations and the assumption of no gap in the connection (AISI S100, 2007). Thus, there is no existing rational means of predicting the shear-resistance performance or designing these types of connections with a gap or, more specifically, a layer of foam sheathing between the connected parts.

While strength of connection may be considered a primary concern in predicting connection performance, other performance-related matters were considered. For example, siding connections must support the weight of siding without excessive deflection. Thus, connection strength should ensure not only safety but also adequate deflection performance. In addition to deflection caused by immediate load application, wood connections and members as well as plastics, such as foam, exhibit a plastic behavior and plastics "creep" over time. Thus, creep effects were additionally considered. No prior research was identified that addressed these concerns for the types of connections considered in this study.

Based on the connection options identified for consideration (as shown in Figure 18), the technical approach was aimed at verifying appropriate use of the NDS Yield Theory for connections with foam sheathing thicknesses of up to four inches and for wood-based substrates (sheathing) as thin as 7/16-inch-thick (i.e., typical OSB sheathing). For these same connections, the withdrawal resistance of fasteners in thin wood-based sheathing was considered technically important, as this application is beyond the limitations of existing codified design knowledge and, therefore, also is in need of verification. Also, the technical approach was aimed at developing a means of predicting connection performance for steel-to-steel (i.e., hat channel to steel stud) and wood-to-steel (i.e., 1x wood furring or siding to steel stud) connections with an intervening gap (layer of foam sheathing). Finally, the technical approach considered creep effects under sustained loading.

To implement these technical objectives, a testing plan was developed. The original test plan included examining individual fastener tests of screws in steel framing, in the interest of attempting to develop a connection design theory similar to that of the NDS Yield Theory. During the course of testing, however, it was determined that assembly tests provided a more valuable use of limited resources and a more realistic basis for an empirical understanding of connection performance within the immediate objectives of this effort.

SUMMARY OF TESTING RESULTS

The following paragraphs present a summary of the findings from the testing effort, based on more detailed information and data found in the laboratory test report (PEI, 2010a) included as Appendix C.   Refer to Appendix C for a detailed accounting of the test results, including test methods, load deflection plots, various material properties (i.e., wood density, steel tensile strength, fastener bending yield, foam density, etc.), and other related information.

Cladding Connection Assembly Shear Tests. Figure 19 pictures a typical connection shear test set-up. Figure 20 summarizes shear test results for the tests conducted with steel furring (33 mil hat channel), 1x wood furring, and cladding connections to steel framing (C-shaped studs). The cladding material was emulated by using a wood furring thickness reduced to 3/8 inches thick at the fastener locations by use of a 2-inch-diameter boring bit. Shear tests simulate the lateral force and displacement that a cladding connection would experience from the weight of the supported cladding material.

Figure 19. Typical Shear Test Set-up (PEI, 201a)

Figure 20. Cladding Connections to Steel Framing

33 mil steel hat channel to steel stud shear tests (steel-to-steel connections with and without gap):

Test ID	Description	gap (foam) inches	Max Load per Screw (lbs)	Defl. @ Max. Load (in.)	Average Load (lbs) per Screw at Deflections: 0.015"	0.125"	0.250"	0.375"	Failure Mode
3.1-(b1)	33mil hat, 1"EPS, 33mil stud, (2) #8x2-3/8" screws w/1/4" washer	1	242.5	0.653	21	40.5	73.5	125.5	II (rotation)
3.1-(b2)	33mil hat, 4"EPS, 54mil stud, (2) #10x5" screws w/1/4" washer	4	557.5	2.079	68	84.5	102	120.5	II (rotation)
3.1-(b3)	33mil hat, no EPS, 33mil stud, (2) #8x2-3/8" screws w/1/4" washer	0	624	0.146	260	594.5	624	624	Im (bearing)
3.1-(b4)	33mil hat, 2"EPS, 33mil stud, (2) #10x3.5" screws w/1/4" washer	2	194.5	0.875	30.5	43.5	60.5	83.5	II (rotation)
3.1-(b5)	33mil hat, 2"EPS, 54mil stud, (2) #10x3.5" screws w/1/4" washer	2	964	1.619	69	96	124.5	157	Im (bearing)

wood furring to steel stud shear tests (wood-to-steel connections with and without gap):

Test ID	Description	gap (foam) inches	Max Load per Screw (lbs)	Defl. @ Max. Load (in.)	Average Load (lbs) per Screw at Deflections: 0.015"	0.125"	0.250"	0.375"	Failure Mode
3.2-(b1-1)	3/4" wood furring, 1"EPS, 33mil stud, (2) #8 screws	1	175	0.387	45	98.5	137	168.5	IIIm
3.2-(b1-3)	3/8" wood furring, 1"EPS, 33mil stud, (2) #8 screws	1	220.5	0.661	41	73.5	103.5	140.5	II (rotation)
3.2-(b1-4)	3/4" wood furring, no EPS, 33mil stud, (2) #8 screws	0	437	0.501	162.5	315	364.5	412	Im (bearing)
3.2-(b1-5)	3/4" wood furring, 2"EPS, 33mil stud, (2) #10 screws	2	205	0.867	33.5	54.5	78.5	98.5	IIIm
3.2-(b2-4)	3/4" wood furring, 2"EPS, 54mil stud, (2) #10 screws	2	411.5	1.599	57	94.5	127.5	159.5	II (rotation)
3.2-(b2-3)	3/8" wood furring, 4"EPS, 54mil stud, (2) #10 screws	4	286.5	1.442	62.5	79	96.5	114.5	II (rotation)

Key to failure modes reported in Figure 20 tables based on AF&PA/NDS (2005)	
Mode Im	Bearing failure in the connected part receiving the fastener point (main member)
Mode II	Rotation of fastener in both connected parts without yielding of the fastener
Mode IIIs	Rotation of fastener in connected part at the fastener head (side member) and bending yield of fastener at interface with connected part receiving the fastener point (main member)
Mode IIIm	Rotation of fastener in connected part receiving fastener point (main member) and bending yield of fastener at interface with connected part at the fastener head (side member)
Mode IV	Bending yield of fastener at interface with both connected parts (main member as side member)

Figure 21 provides a summary of shear test results for steel furring (33 mil hat channel) and wood furring connections to 7/16-inches-thick and ¾-inches-thick OSB sheathing used as a fastening base. Because the connection was to a wood-based sheathing material, nails and screws were used for steel furring (with pre-drilled holes) and wood furring connections. All these tests included foam sheathing thicknesses of 1 inch, 2 inches, and 4 inches. A few tests also included no foam sheathing between the connected parts. These tests formed a baseline or control group for comparison of existing connection design theory based on the absence of a gap (no foam sheathing) in the connection. The discussion next turns to analysis of these results. Figure 22 shows two typical shear load-deflection plots.

Figure 21. Cladding Connections to OSB Sheathing

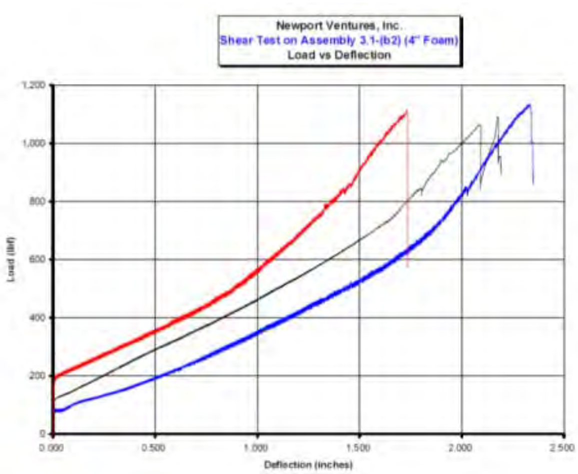
33 mil steel hat channel to OSB wood structural panel sheathing (steel-to-wood connections with and without gap):

Test ID	Description		Max Load per Nail (lbs)	Defl. @ Max. Load (in.)	Average Load (lbs) per Nail at Deflections: 0.015"	0.125"	0.250"	0.375"	Failure Mode
3.1-(a1)	33mil hat, 1"EPS, 7/16" OSB, (4) 0.099"x2.25" nails		83	1.295	15.5	37.75	50.25	58.75	IV
3.1-(a2)	33mil hat, 4"EPS, 23/32" OSB, (4) 0.135" (10g) x 6" nails		192.75	3.372	19.75	37.5	53.5	67	IIIs
3.1-(a3)	33mil hat, no EPS, 7/16"OSB, (4) 0.099"x2.25" nails		200.5	0.101	81	200.25	200.5	200.5	IIIs

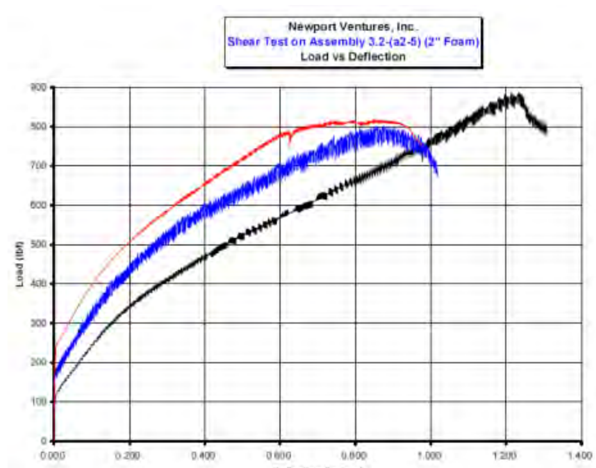
wood furring to OSB wood structural panel sheathing (wood-to-wood connections with and without gap):

Test ID	Description	gap (foam) inches	Max Load per Fastener (lbs)	Defl. @ Max. Load (in.)	Average Load (lbs) per Fastener at Deflections: 0.015"	0.125"	0.250"	0.375"	Failure Mode
3.2-(a1-1)	3/4" wood furring, 1" EPS, 7/16" OSB, (2) #8 x 3" wood screws	1	192	0.463	68	122	159	182	IIIm
3.2-(a1-3)	3/8" wood furring, 1"EPS, 7/16" OSB, (2) 0.099"x2-1/4" nails	1	72	0.898	24.5	43	53.5	62	IIIm
3.2-(a1-4)	3/4" wood furring, no EPS, 7/16" OSB, (2) #8 x 1.5" wood screws	0	319	0.296	176.5	254.5	311	319	IIIm
3.2-(a2-1)	3/4" wood furring, 4" EPS, 23/32" OSB, (2) 1/4"x6" lags	4	344	1.437	78	109.5	133	156.5	IIIm
3.2-(a2-3)	3/4" wood furring, 4" EPS, 23/32" OSB, (2) 0.135"x6" nails	4	162.5	2.863	41.5	57.5	73	72.5	IV
3.2-(a2-4)	3/4" wood furring, no EPS, 23/32" OSB, (2) 1/4"x2" lags	0	814	0.679	199.5	499	610.5	702.5	II
3.2-(a2-5)	3/4" wood furring, 2" EPS, 23/32" OSB, (2) 1/4"x4" lags	2	418.5	0.988	99	175.5	238	278	II

Figure 22. Typical Shear Load-Deflection Plots (PEI, 2010a)
(three assembly specimens tested for each assembly condition)



Assembly 3.1-(b2): 33mil hat channel, 4" EPS Type II Foam, 54mil steel stud, (2) #10 drill-point screws



Assembly 3.2-(a2-5): ¾" wood furring, 4" EPS Type II Foam, ¾"OSB, (2) ¼" lag screws

Wood Frame Cladding Connection Baseline Tests. To provide insight into comparable performance of similar connections made to wood studs, additional tests were performed (see Figure 23). These tests provide a basis for evaluating wood-to-wood connection performance as predicted by the NDS Yield Theory, with application of the earlier mentioned gap parameter. These tests were also supplemented by a number of similar trials using a wider variety of fasteners and foam thicknesses conducted for the Foam Sheathing Coalition by the same test lab (PEI, 2010b). Results are similar and are shown in Figure 24.

Figure 23. Comparative Wood Frame Cladding Connection Tests

wood furring to wood studs (wood-to-wood connections with and without gap):

Test ID	Description	gap (foam) inches	Max Load per Fastener (lbs)	Defl. @ Max. Load (in.)	Average Load (lbs) per Fastener at Deflections: 0.015"	0.125"	0.250"	0.375"	Failure Mode
3.2-(c1)	3/4" wood furring, 1" EPS, 2x4 wood stud, (2) 0.135"x3.5" nails	1	508	1.753	98	184	236.5	291	IV
3.2-(c2)	3/4" wood furring, 4" EPS, 2x4 wood stud, (2) 1/4"x7" Lags	4	549.5	2.207	64	101	137.5	171.5	IIIs

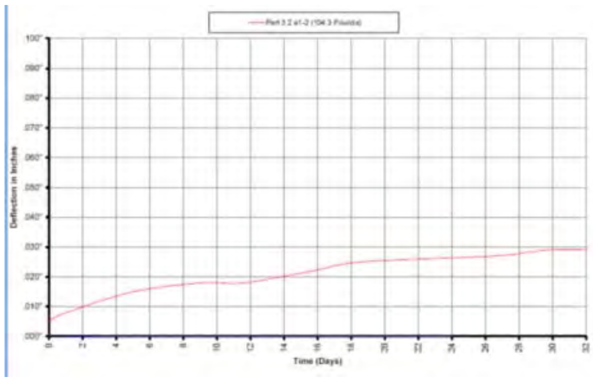
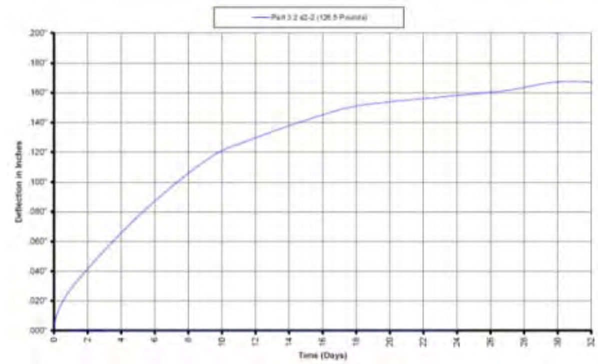
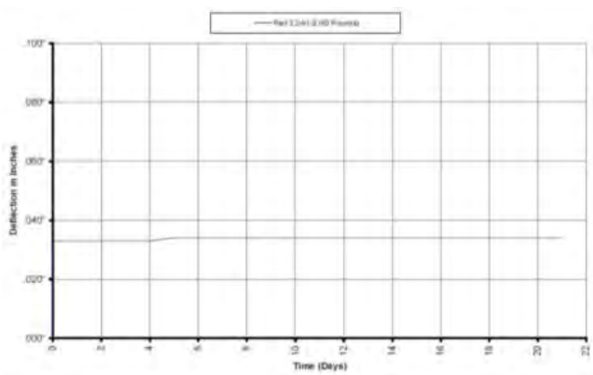
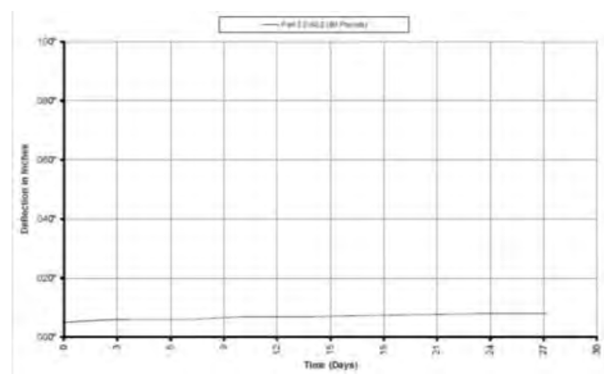
Figure 24. Supplemental Wood Frame Cladding Tests (Foam Sheathing Coalition)

FSC TESTING -- wood furring to wood studs (wood-to-wood connections with and without gap):

Test ID	Description	gap (foam) inches	Max Load per Fastener (lbs)	Defl. @ Max. Load (in.)	Average Load (lbs) per Fastener at Deflections: 0.015"	0.125"	0.250"	0.375"	Failure Mode
a1-screw	3/4" wood furring, (2) #8 wood screw, no foam	0	470	0.67	190	321	377	415	IIIs
a2-screw	3/4" wood furring, (2) #8 wood screw, 1" EPS foam	1	428	1.116	60	119	169	215	IIIs
a3-nail	3/4" wood furring, (2) 16d box (0.135"x3.5") nail, no foam	0	686	1.126	177	362	460	538	IIIs
a4-nail	3/4" wood furring, (2) 16d box (0.135"x3.5") nail, 1" EPS	1	503	1.515	51	128	183	242	IIIm
a5-nail	3/4" wood furring, (2) 0.135x4" foundry nail, 2" EPS	2	179	1.532	70	100	116	127	IIIm
a6-nail	3/4" wood furring, (2) 0.135x6" foundry nails, 4" EPS	4	184	1.87	46	71	98	119	IIIm
a7-lag	3/4" wood furring, (2) 1/4x2" lag screws, no foam	0	933	0.639	170	505	654	784	II
a8-lag	3/4" wood furring, (2) 1/4x3" lag screws, 1" EPS	1	745	1.225	69	168	243	309	IV
a9-lag	3/4" wood furring, (2) 1/4x4" lag screws, 2" EPS	2	649	1.536	91	161	209	248	IIIs
a10-lag	3/4" wood furring, (2) 1/4x6" lag screws, 4" EPS	4	551	2.505	48	78	103	127	IIIs
b1-nail	3/8" wood furring, (2) 8d box (0.113x2.5") nails, no foam	0	221	0.238	98	204	219	221	IIIm
b2-nail	3/8" wood furring, (2) 8d box (0.113x2.5") nails, 1/2" EPS	0.5	161	0.982	77	120	138	144	IV
b3-nail	3/8" wood furring, (2) 8d box (0.113x2.5") nails, 1" EPS	1	125	1.036	39.5	67	86	94	IIIs
b4-nail	3/8" wood furring, (2) 16d box (0.135x3.5") nails, 1" EPS	1	288	0.73	55	96	125	168	IIIs
b5-nail	3/8" wood furring, (2) 16d (0.135x4") foundry nails, 2" EPS	2	155	1.121	56	77	95	104	IIIs

Cladding Connection Assembly Shear Creep Tests. Figure 25 reports data on one-month-long creep tests of selected cladding connection assemblies. These tests show a creep effect for connections to 7/16 inch and ¾ inch OSB sheathing. Nevertheless, creep effects with connections to steel studs appear negligible.

Figure 25. Cladding Connection Shear Creep Tests (PEI, 2010a)

	
Assembly 3.2-(a1-2): ¾" wood furring, 1" EPS Type II Foam,7 /16" OSB, (2) #8x3" wood screws (104.3 lbs for 32 days)	Assembly 3.2-(a2-2): ¾" wood furring, 4" EPS Type II Foam, ¾" OSB, (2) ¼" lag screws (126.5 lbs for 32 days)
	
Assembly 3.2-(b1-2): ¾" wood furring, 1" EPS Type II Foam, 33mil steel stud, (2) #8 drill-point screws (60 lbs for 21 days)	Assembly 3.2-(b2-2): 3/8" wood furring, 4" EPS Type II Foam, 54mil steel stud, (2) #10 drill-point screws (80 lbs for 27days)

<u>Fastener Withdrawal Tests in OSB Sheathing</u>. Figure 26 presents results from fastener withdrawal tests in OSB sheathing. These results indicate a decreasing performance trend in comparison with predicted withdrawal capacity for nail fasteners with increasing nail diameter and decreasing sheathing thickness (AF&PA/NDS 2005). Thus, additional testing should be conducted to more fully characterize these effects for design purposes. For this reason, and for reasons addressed earlier regarding creep effects, use of OSB sheathing as a means of cladding connection was considered premature. Further study would be required before appropriate use within the scope and intent of this study can be determined. The need for this additional work is also relevant to other applications, such as siding connections to Structural Insulated Panels (SIP), which use OSB skins on a foam core as a structural wall system. There is only limited framing at panel splices to which cladding materials can be connected.

Figure 26. Fastener Withdrawal Tests in OSB

Withdrawal Test Data in OSB Sheathing					
		Pre-drilled		**Not Pre-drilled**	
Fastener	**OSB Thickness**	**Test W (lbs)-avg**	**Test W COV**	**Test W (lbs)-avg**	**Test W COV**
7d box	7/16	37.7	0.09	36.6	0.36
	3/4	64.1	0.11	62.3	0.32
16d box	7/16	84.8	0.17	55.9	0.17
	3/4	174.7	0.24	100	0.23
16d com	7/16	64.3	0.21		
	3/4	114.9	0.12		
#8 wd.sc.	7/16	214.4	0.24		
	3/4	387	0.18		
1/4"lg.sc.	7/16	321.3	0.22		
	3/4	521.2	0.21		

ANALYSIS OF RESULTS

Design Performance Criteria. Based on the test results and reviewed precedents for cladding connection performance criteria, investigators decided on a minimum safety factor of 2.0 (relative to average shear strength) and a maximum short-term load deflection of 0.015-inch as the basis of developing model building code requirements. (See Appendix B). The 0.015-inch deflection limit is a long-standing basis for wood connection design values as used in AF&PA/NDS, 2005. This basis for design has a long history of successful performance with materials such as wood, which demonstrate creep effects under sustained load. Because any connection with an intervening layer of foam may exhibit creep effects or increased tendency for displacement under load (including steel-to-steel connections with an intervening layer of foam), the 0.015-inch deflection criterion provided a logical and consistent basis for design based on current knowledge. In all cases for gapped connections, the 0.015-inch deflection limit controlled design values and thus prediction of connection performance was based on predicted shear load capacity of the connections at a 0.015-inch deflection limit.

For siding connections to steel framing, designing to meet a 0.015-inch deflection limit resulted in a safety margin (relative to the tested ultimate capacity) of about seven on average (range of 4-to-14 for gapped connections) (see Appendix A for analysis of test data . For connections to wood materials (i.e., OSB sheathing or studs), the safety margin relative to the targeted 0.015-inch deflection limit was about 5.6 on average (range of 3-to-15 for gapped connections). However, an additional safety factor of 1.5 for connections to wood materials was applied to account for potential creep effects (as only evaluated for connections to OSB sheathing, not wood studs, per Figure 25). Consequently, the net safety factor is about 8.3, relative to tested ultimate shear load capacities of assemblies with connections to wood materials. Overall, this approach resulted in the application of a reasonably consistent basis of connection performance and durability (long term deflection control) to all connection options and materials considered. An analysis of the test data with respect to these performance criteria follows.

As Appendix C shows, this approach — using a 5% offset yield prediction of cladding connections to wood-based materials using the NDS Yield Theory (AF&PA/NDS, 2005; AF&PA/TR-12, 1999) with the gap parameter — resulted in a reasonably accurate prediction of the shear load at a deflection of 0.015 inch based on the connection assembly tests. The prediction had a slight non-conservative bias of about 7% in over-predicting tested shear loads at a 0.015-inch deflection. Thus, for calculation purposes in deriving building code requirements (see Appendix B), the use of a 5% offset yield prediction was considered to be an adequate basis of designing for a 0.015-inch deflection limit. This is especially true with an additional safety factor of 1.5 applied to the calculated result for purpose of controlling potential long-term creep effects.

Design Methodology for Cladding Connections to Steel Framing. As discussed earlier, a suitable design theory for gapped connections (i.e., with foam sheathing in between the connected parts) does not currently exist for cold-formed steel framing. Thus, researchers evaluated the test data to develop an empirical "gap reduction factor" approach, to be applied with the screw fastener connection design approach found in AISI S100 (2007), Section E4. Evaluating the data in Appendix B for cladding connections to steel framing resulted in empirical gap reduction factor equations to be applied as a reduction factor adjustment to Equation E4.3.1-1 in AISI S100-07 (Section E4.3.1) to account for gap effects due to the presence of foam sheathing between the connected parts. This approach was modeled, at least in part, after a similar strength-based approach proposed for much smaller gaps (Bambach and Rasmussen, 2007). Still, the approach used in this study provided gap reduction factors that controlled shear strength to a 0.015-inch deflection limit for reasons mentioned earlier. Thus, when calculating P_{ns}(nominal connection shear resistance) per AISI S100-07 Equation E4.3.1-1 (tilting failure mode) and applying the required safety factor of three per AISI S100-07 Section E4, the resulting factored design value provides a design resistance value approximating that for a 0.015-inch deflection (slip).

To implement the gap reduction factor procedure described above and to provide a means of calculating siding connection requirements discussed next, researchers modified the screw fastener design method in AISI S100-07 Section E4.3.1 as follows (modifications shown as underlined):[4]

E4.3.1 Shear Strength [Resistance] Limited by Tilting and Bearing

The nominal shear strength [resistance] per screw, P_{ns}, shall be determined in accordance with this section.

For $t_2/t_1 \leq 1.0$, P_{ns} shall be taken as the smallest of

$$P_{ns} = 4.2\,(t_2^3 d)^{1/2} F_{u2} \qquad (Eq.\ E4.3.1\text{-}1)$$

[4] Variables used are as defined in AISI S100-07 Section E4. Variables 't_1' and 't_2' represent the thickness of steel materials in contact with the screw fastener head and not in contact with the head, respectively. Variable 'd' is the nominal screw fastener diameter. F_{u1} and F_{u2} represent the steel tensile strength of the member in contact and not in contact, respectively, with the screw fastener head.

$P_{ns} = 2.7\ t_1\ d\ F_{u1}$ (*Eq.* E4.3.1-2)

$P_{ns} = 2.7\ t_2\ d\ F_{u2}$ (*Eq.* E4.3.1-3)

For $t_2 / t_1 \geq 2.5$, P_{ns} shall be taken as the smallest of

$P_{ns} = 2.7\ t_1\ d\ F_{u1}$ (*Eq.* E4.3.1-4)

$P_{ns} = 2.7\ t_2\ d\ F_{u2}$ (*Eq.* E4.3.1-5)

For $1.0 < t_2/t_1 < 2.5$, P_{ns} shall be calculated by linear interpolation between the above two cases.

For connections with a gap between the connected steel parts filled with a material with properties at least equivalent to Type II Expanded Polystyrene Foam (ASTM C578), Eq. 4.3.1-1 shall be multiplied by one of the following gap effect reduction factors, G_r, as appropriate:

$G_r = 0.17 – 0.0048(r)$ (for #10 self-drilling, tapping screw in minimum 54 mil and 50 ksi steel)

$G_r = 0.19 – 0.0068(r)$ (for #10 screw in minimum 43 mil and 33ksi steel)

$G_r = 0.16 – 0.0061(r)$ (for #8 or #10 screw in minimum 33 mil and 33ksi steel)

where,

G_r = gap effect reduction factor for *Eq.* E4.3.1-1

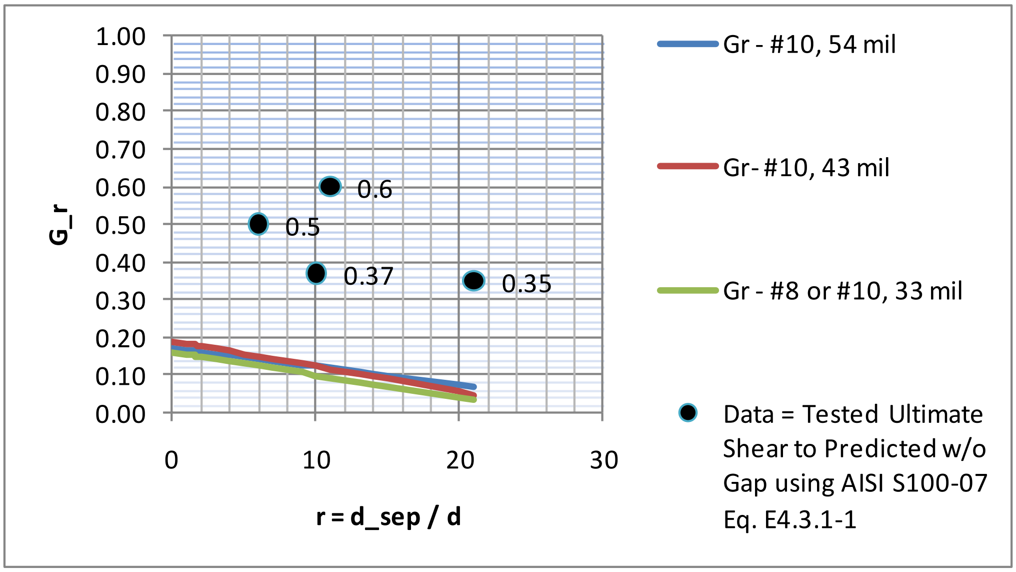
$r = d_{sep}/d$

d_{sep} = the distance between the connected steel parts (i.e., gap)

The above G_r equations apply only to joints where r is 21 or less resulting in a minimum joint deflection after application of the required Allowable Stress Design (ASD) safety factor of 0.015 inch at the ASD design load. The material placed against the fastener head must be minimum 33mil and 33 ksi steel or minimum 3/8-inch thick wood based or similar material with a specific gravity of not less than 0.42. For small gaps with $0<r<2$, the value of G_r need not be less than $(1 – r/2)$.

Figure 27 shows these G_r factor equations as applied above relative to test data for tested assemblies with 33 mil hat channel and various thicknesses of foam sheathing (range of ‘r’ values), steel thicknesses (33 mil and 54 mil), and screw sizes (#8 and #10). Figure 27 does not show data for wood furring, although the results are very similar. Because the results were similar, and a means of predicting connections of wood-to-steel parts (i.e., wood furring to steel studs) was not separately developed, it was deemed sufficient to permit substitution of a wood furring or cladding material for design value predictions based on the 33 mil hat channel.

Figure 27. Plot of Gap Reduction Factor Equations vs. Test Data at Failure Load



The plotted data points (●) in Figure 27 represent the ratio of tested ultimate capacity to the predicted nominal capacity using AISI S100-07 Eq. 4.3.1-1 for tested joints with gaps resulting in values of 'r' as shown on the x-axis. The G_r lines at the bottom of the plot are the gap effect reduction factor equations applied to AISI S100-07 Eq. 4.3.1-1 at the nominal strength level as presented earlier in the modified design methodology. The actual design result, after application of a safety factor of three, would result in connection design shear values that fall below these G_r lines by a factor of 3 which correspond to a 0.015-inch deflection limit as discussed previously. Thus, Figure 27 illustrates the margin of safety and relationship between actual tested performance and the design method discussed earlier.

PRESCRIPTIVE REQUIREMENTS FOR BUILDING CODES

Figures 28 and 29 present recommended building code requirements for siding attachments to steel framing and wood framing with an intervening layer of continuous insulation. Permissible thicknesses of continuous insulation ranges up to 4 inches depending on the fastener type, framing type, fastener spacing, and siding weight. These tables are extracted from a more comprehensive building code proposal included in Appendix B. The reader is cautioned that Figures 28 and 29 should be used with consideration of the additional requirements included in Appendix B.

The siding attachments to steel-framing data were analyzed using the modified AISI S100-07 design method discussed in the previous section as derived from test data. The attachments to wood framing were derived using the AF&PA/NDS (2005) and AF&PA/TR-12 (1999) yield equations (5% offset yield values) with gap parameter discussed previously. In both cases, the analysis approach limited siding deflection due to weight of the siding acting on the connection to no more than about 0.015-inch deflection.

Researchers used three sliding weight classes to facilitate prescribing connection requirements in Figures 28 and 29. The 3psf siding weight class covers products like fiber-cement siding (and also conservatively applies to light-weight products such as vinyl siding). The 11 psf category is meant to address medium weight siding materials such as Portland cement plaster. The 25 psf siding weight class addresses heavy weight siding materials such as adhered masonry veneers. In all cases, only standardized or code-recognized fasteners were considered, in order to avoid problems with including proprietary (sole source) solutions in model building codes or state and local building codes. Nevertheless, the design approaches discussed earlier, which serve as the basis of Figures 28 and 29, are potentially applicable to a variety of proprietary fasteners.

Figure 28. Siding Minimum Fastening Requirements for Direct Siding Attachment over Foam Plastic Sheathing to Support Siding Weight[1]

Siding Fastener Through Foam Sheathing into:	Siding Fastener Type and Minimum Size[2]	Siding Fastener Vertical Spacing (inches)	Maximum Foam Sheathing Thickness (inches)					
			16"oc Fastener Horizontal Spacing			24"oc Fastener Horizontal Spacing		
			Siding Weight:			Siding Weight:		
			3 psf	11 psf	25 psf	3 psf	11 psf	25 psf
Wood Framing (minimum 1-1/4 inch penetration)	0.113" diameter nail	6	4	3	1	4	2	0.75
		8	4	2	0.75	4	1.5	DR
		12	4	1.5	DR	3	0.75	DR
	0.120" diameter nail	6	4	3	1.5	4	2	0.75
		8	4	2	1	4	1.5	0.5
		12	4	1.5	0.5	3	1	DR
	0.131" diameter nail	6	4	4	1.5	4	3	1
		8	4	3	1	4	2	0.75
		12	4	2	0.75	4	1	DR
Steel Framing (minimum penetration of steel thickness + 3 threads)	#8 screw into 33 mil steel or thicker	6	3	3	1.5	3	2	DR
		8	3	2	0.5	3	1.5	DR
		12	3	1.5	DR	3	0.75	DR
	#10 screw into 33 mil steel	6	4	3	2	4	3	0.5
		8	4	3	1	4	2	DR
		12	4	2	DR	3	1	DR
	#10 screw into 43 mil steel or thicker	6	4	4	3	4	4	2
		8	4	4	2	4	3	1.5
		12	4	3	1.5	4	3	DR

For SI: 1 inch = 25.4 mm; 1 pound per square foot (psf) = 0.0479 kPa
DR = design required

1. Tabulated requirements are based on wood framing of Spruce-Pine-Fir or any wood species with a specific gravity of 0.42 or greater in accordance with AF&PA/NDS and minimum 33 ksi steel for 33 mil and 43 mil steel and 50 ksi steel for 54 mil steel or thicker.
2. Fasteners shall comply with appropriate standards and manufacturer's installation instructions, or be otherwise approved for the intended application.
3. Refer to Appendix C for additional requirements related to use of this table.

Figure 29. Furring Minimum Fastening Requirements for Application Over Foam Plastic Sheathing to Support Siding Weight[1,2]

Furring Material	Framing Member	Fastener Type and Minimum Size	Minimum Penetration into Wall Framing (inches)	Fastener Spacing in Furring (inches)	Maximum Thickness of Foam Sheathing (inches)						Allowable Design Wind Pressure (psf)	
					16"oc Furring[4]			24"oc Furring[4]				
					Siding Weight:			Siding Weight:				
					3 psf	11 psf	25 psf	3 psf	11 psf	25 psf	16"oc Furring	24"oc Furring
Minimum 1x Wood Furring[3]	Minimum 2x Wood Stud	Nail (0.120" shank; 0.271" head)	1-1/4	8	4	4	1.5	4	2	1	42.6	28.4
				12	4	2	1	4	1.5	0.5	28.4	18.9
				16	4	2	0.5	4	1	DR	21.3	14.2
		Nail (0.131" shank; 0.281" head)	1-1/4	8	4	4	2	4	3	1	46.5	31.0
				12	4	3	1	4	2	0.75	31.0	20.7
				16	4	2	0.75	4	1.5	DR	23.3	15.5
		#8 wood screw[5]	1	12	4	4	1.5	4	3	1	98.9	66.0
				16	4	3	1	4	2	0.5	74.2	49.5
				24	4	2	0.5	4	1	DR	35.1	23.4
		¼" lag screw[5]	1-1/2	12	4	4	3	4	4	1.5	140.4	93.6
				16	4	4	2	4	3	1	79.0	52.7
				24	4	3	1	4	2	0.5	35.1	23.4
Minimum 33mil Steel Hat Channel or Minimum 1x Wood Furring[3]	33 mil Steel Stud	#8 screw (0.285" head)	Steel thickness +3 threads	12	3	1.5	DR	3	0.5	DR	52.9	35.3
				16	3	1	DR	2	DR	DR	39.7	26.5
				24	2	DR	DR	2	DR	DR	26.5	17.6
		#10 screw (0.333" head)	Steel thickness +3 threads	12	4	2	DR	4	1	DR	62.9	41.9
				16	4	1.5	DR	3	DR	DR	47.1	31.4
				24	3	DR	DR	2	DR	DR	31.4	21.0
	43 mil or thicker Steel Stud	#8 screw (0.285" head)	Steel thickness +3 threads	12	3	1.5	DR	3	0.5	DR	69.0	46.0
				16	3	1	DR	2	DR	DR	51.8	34.5
				24	2	DR	DR	2	DR	DR	34.5	23.0
		#10 screw (0.333" head)	Steel thickness +3 threads	12	4	3	1.5	4	3	DR	81.9	54.6
				16	4	3	0.5	4	2	DR	61.5	41.0
				24	4	2	DR	4	0.5	DR	35.1	23.4

For SI: 1" = 25.4 mm; 1 pound per square foot (psf) = 0.0479 kPa. DR = design required

1. Table values are based on: (1) minimum ¾-inch (19.1 mm) thick wood furring and wood studs of Spruce-Pine-Fir or any softwood species with a specific gravity of 0.42 or greater per AF&PA/NDS, (2) minimum 33 mil steel hat channel furring of 33 ksi steel, and (3) steel framing of indicated nominal steel thickness and minimum 33 ksi steel for 33mil and 43 mil steel and 50 ksi steel for 54 mil steel or thicker. Steel hat channel shall have a minimum 7/8-inch (22.2 mm) depth.
2. Fasteners shall comply with appropriate standards and manufacturer's installation instructions, or be otherwise approved for the intended application.
3. Where the required siding fastener penetration into wood material exceeds ¾ inch (19.1 mm) and is not more than 1-1/2 inches (38.1 mm), a minimum 2x wood furring shall be used unless approved deformed shank siding nails or siding screws are used to provide equivalent withdrawal strength allowing connection to 1x wood furring.
4. Furring shall be spaced a maximum of 24"oc in a vertical or horizontal orientation. In a vertical orientation, furring shall be located over wall studs and attached with the required fastener spacing. In a horizontal orientation, furring strips shall be fastened at each stud intersection with a number of fasteners equivalent to the required fastener spacing. In no case shall fasteners be spaced more than 24 inches (0.6 m) apart.
5. Lag screws shall be installed with a standard cut washer. Lag screws and wood screws shall be pre-drilled in accordance with AF&PA/NDS. Approved self-drilling screws of equal or greater shear and withdrawal strength shall be permitted without pre-drilling.
6. Refer to Appendix C for additional requirements related to use of this table.

CONCLUSIONS

In general, this project achieved its objectives. In particular, useful applications of the data have resulted in new means of designing cladding or similar connections to steel framing when a gap exists between the joined parts, such as required for continuous (rigid foam) insulation. In addition, this work has verified the NDS Yield Theory for general wood connections and extended it for appropriate application to cladding connections over foam sheathing. In both cases, practical solutions for continuous insulation thicknesses up to four inches were achieved as represented in model building code proposals included in Appendix B and the excerpted siding attachment tables included in this report, as Figures 28 and 29 have shown.

RECOMMENDATIONS

Additional work is recommended in the area of cladding connections to wood-based sheathing materials, such as OSB. While the research indicated feasibility, areas of concern needing further investigation include effects of limited penetration lengths of screw and nail fasteners on withdrawal capacity and effects of creep on long term cladding fastener performance in wood-based sheathing materials. In addition, research is recommended to develop a generalized, mechanics-based connection theory for steel framing similar to the NDS Yield Theory for wood connections. Such a connection design approach for cold-formed steel framing would promote a wider variety of connection solutions and innovation.

REFERENCES FOR SECTION 4

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APPENDIX A TO SECTION 4 - ANALYSIS OF CLADDING CONNECTIONS

Cladding Connections to Cold-formed Steel Studs

Test ID	Description	gap (foam) inches	per Screw (lbs)	Max. Load (in.)	0.015"	0.125"	0.250"	0.375"	Failure Mode	t1 (hat) inches	t2 (stud) inches	Fu (hat) psi	Fu (stud) psi	d-min inches	d-max inches	Fyb (screw) psi	at 0.015" Defl.	0.015" / Max Load
3.1-(b1)	33mil hat, 1"EPS, 33mil stud, (2) #8x2-3/8" screws w/1/4" washer	1	242.5	0.653	21	40.5	73.5	125.5	II (rotation)	0.034	0.0313	81747	48142	0.108	0.159	273991	21	11.5
3.1-(b2)	33mil hat, 4"EPS, 54mil stud, (2) #10x5" screws w/1/4" washer	4	557.5	2.079	68	84.5	102	120.5	II (rotation)	0.034	0.0537	81747	67267	0.13	0.185	258580	68	8.2
3.1-(b3)	33mil hat, no EPS, 33mil stud, (2) #8x2-3/8" screws w/1/4" washer	0	624	0.146	260	594.5	624	624	Im (bearing)	0.034	0.0313	81747	48142	0.108	0.159	262227	n/a -- use AISI E4.3.1	
3.1-(b4)	33mil hat, 2"EPS, 33mil stud, (2) #10x3.5" screws w/1/4" washer	2	194.5	0.875	30.5	43.5	60.5	83.5	II (rotation)	0.034	0.0313	81747	48142	0.131	0.184	228194	30.5	6.4
3.1-(b5)	33mil hat, 2"EPS, 54mil stud, (2) #10x3.5" screws w/1/4" washer	2	964	1.619	69	96	124.5	157	Im (bearing)	0.034	0.0537	81747	67267	0.131	0.184	228194	69	14.0
NOTE: 3 reps were performed for each assembly																		
All screws were bugle head, self-drilling tapping screws; 1/4" washer was standard cut washer; d-min is root diameter at threads, d-max is diameter of unthreaded portion.																		
wood furring to steel stud shear tests (wood-to-steel connections with and without gap):																		
			Max Load	**Defl. @**	**Average Load (lbs) per Screw at Deflections:**					**Material Properties & Dimensions (averaged)**					nominal			
Test ID	**Description**	**gap (foam)**	**per Screw**	**Max. Load**	**0.015"**	**0.125"**	**0.250"**	**0.375"**	**Failure**	t1 (furring	t2 (stud)	G (furring	Fu (stud)	d-min	d-max	Fyb (screw)		
		inches	**(lbs)**	**(in.)**					**Mode**	inches	inches	sp.grav.	psi	inches	inches	psi		
3.2-(b1-1)	3/4" wood furring, 1"EPS, 33mil stud, (2) #8 screws	1	175	0.387	45	98.5	137	168.5	IIIm	0.75	0.0313	0.48	48142	0.108	0.159	273991	45	3.9
3.2-(b1-3)	3/8" wood furring, 1"EPS, 33mil stud, (2) #8 screws	1	220.5	0.661	41	73.5	103.5	140.5	II (rotation)	0.375	0.0313	0.48	48142	0.108	0.159	273991	41	5.4
3.2-(b1-4)	3/4" wood furring, no EPS, 33mil stud, (2) #8 screws	0	437	0.501	162.5	315	364.5	412	Im (bearing)	0.75	0.0313	0.48	48142	0.108	0.159	273991	162.5	2.7
3.2-(b1-5)	3/4" wood furring, 2"EPS, 33mil stud, (2) #10 screws	2	205	0.867	33.5	54.5	78.5	98.5	IIIm	0.75	0.0313	0.48	48142	0.131	0.184	228194	33.5	6.1
3.2-(b2-4)	3/4" wood furring, 2"EPS, 54mil stud, (2) #10 screws	2	411.5	1.599	57	94.5	127.5	159.5	II (rotation)	0.75	0.0537	0.48	67267	0.131	0.184	228194	57	7.2
3.2-(b2-3)	3/8" wood furring, 4"EPS, 54mil stud, (2) #10 screws	4	286.5	1.442	62.5	79	96.5	114.5	II (rotation)	0.375	0.0537	0.48	67267	0.13	0.185	144606	62.5	4.6
NOTE: 3 reps were performed for each assembly																	AVG =	**7.0**
33 mil steel hat channel to OSB wood structural panel sheathing (steel-to-wood connections with and without gap):																		

Cladding Connections to Wood Materials (OSB Sheathing and Wood Studs)

33 mil steel hat channel to OSB wood structural panel sheathing (steel-to-wood connections with and without gap):

Test ID	**Description**	**Max Load per Nail (lbs)**	**Defl. @ Max. Load (in.)**	**Average Load (lbs) per Nail at Deflections: 0.015"**	**0.125"**	**0.250"**	**0.375"**	**Failure Mode**	**Material Properties & Dimensions (averaged)** t1 (hat) inches	t2 (OSB) inches	Fu (hat) psi	G (OSB) sp.grav.	d (nail) inches	Fyb (nail) psi	gap (foam) inches	**NDS/TR12 5% offset (lbs)**	**RATIO 5%offset to 0.015"**	**Safety Margin**
3.1-(a1)	33mil hat, 1"EPS, 7/16" OSB, (4) 0.099"x2.25" nails	83	1.295	15.5	37.75	50.25	58.75	IV	0.034	0.441	81747	0.65	0.1	130350	1	23	1.48	3.61
3.1-(a2)	33mil hat, 4"EPS, 23/32" OSB, (4) 0.135" (10g) x 6" nails	192.75	3.372	19.75	37.5	53.5	67	IIIs	0.034	0.714	81747	0.64	0.135	120348	4	13	0.66	14.83
3.1-(a3)	33mil hat, no EPS, 7/16"OSB, (4) 0.099"x2.25" nails	200.5	0.101	81	200.25	200.5	200.5	IIIs	0.034	0.441	81747	0.65	0.1	130350	0	133	1.64	1.51

NOTE: 3 reps were performed for each assembly

wood furring to OSB wood structural panel sheathing (wood-to-wood connections with and without gap):

Test ID	**Description**	**gap (foam) inches**	**Max Load per Fastener (lbs)**	**Defl. @ Max. Load (in.)**	**Average Load (lbs) per Fastener at Deflections: 0.015"**	**0.125"**	**0.250"**	**0.375"**	**Failure Mode**	**Material Properties & Dimensions (averaged)** t1 (furring inches	t2 (OSB) inches	G (furring) sp. Grav.	G (OSB) sp.grav.	d-min inches	d-max inches	Fyb (fastener) psi			
3.2-(a1-1)	3/4" wood furring, 1" EPS, 7/16" OSB, (2) #8 x 3" wood screws	1	192	0.463	68	122	159	182	IIIm	0.75	0.441	0.48	0.65	0.115	0.16	115000	84	1.24	2.29
3.2-(a1-3)	3/8" wood furring, 1"EPS, 7/16" OSB, (2) 0.099"x2-1/4" nails	1	72	0.898	24.5	43	53.5	62	IIIm	0.375	0.441	0.48	0.65	n/a	0.1	130350	30	1.22	2.40
3.2-(a1-4)	3/4" wood furring, no EPS, 7/16" OSB, (2) #8 x 1.5" wood screws	0	319	0.296	176.5	254.5	311	319	IIIm	0.75	0.441	0.48	0.65	0.111	0.157	115000	188	1.07	1.70
3.2-(a2-1)	3/4" wood furring, 4" EPS, 23/32" OSB, (2) 1/4"x6" lags	4	344	1.437	78	109.5	133	156.5	IIIm	0.75	0.714	0.48	0.64	0.179	0.245	78654	51	0.65	6.75
3.2-(a2-3)	3/4" wood furring, 4" EPS, 23/32" OSB, (2) 0.135"x6" nails	4	162.5	2.863	41.5	57.5	73	72.5	IV	0.75	0.714	0.48	0.64	n/a	0.135	120348	24	0.58	6.77
3.2-(a2-4)	3/4" wood furring, no EPS, 23/32" OSB, (2) 1/4"x2" lags	0	814	0.679	199.5	499	610.5	702.5	II	0.75	0.714	0.48	0.64	0.179	0.245	90000	356	1.78	2.29
3.2-(a2-5)	3/4" wood furring, 2" EPS, 23/32" OSB, (2) 1/4"x4" lags	2	418.5	0.988	99	175.5	238	278	II	0.75	0.714	0.48	0.64	0.179	0.245	110122	104	1.05	4.02

NOTE: 3 reps each assembly, except 1 rep for 3.2-(a1-3) and 3.2-(a2-3)

Long term creep test 3.2-(a1-2), same as 3.2-(a1-1), at 104.3lbs applied load(52 lbs per #8 wood screw), resulted in about 0.025" increase in total deflection over 30 days and was levelling off.

Long term creep test 3.2-(a2-2), same as 3.2-(a2-1), at 126.5 lbs applied load (63 lbs per lag), resulted in about 0.15" increase in total deflection over 30 days and was levelling off.

wood furring to wood studs (wood-to-wood connections with and without gap):

Test ID	**Description**	**gap (foam) inches**	**Max Load per Fastener (lbs)**	**Defl. @ Max. Load (in.)**	**Average Load (lbs) per Fastener at Deflections: 0.015"**	**0.125"**	**0.250"**	**0.375"**	**Failure Mode**	**Material Properties & Dimensions (averaged)** t1 (furring inches	t2 (stud) inches	G (furring) sp. Grav.	G (stud) sp.grav.	d-min inches	d-max inches	Fyb (fastener) psi			
3.2-(c1)	3/4" wood furring, 1" EPS, 2x4 wood stud, (2) 0.135"x3.5" nails	1	508	1.753	98	184	236.5	291	IV	0.75	1.75	0.48	0.44	n/a	0.134	107539	77	0.79	6.60
3.2-(c2)	3/4" wood furring, 4" EPS, 2x4 wood stud, (2) 1/4"x7" Lags	4	549.5	2.207	64	101	137.5	171.5	IIIs	0.75	2.25	0.48	0.44	0.179	0.238	96434	53	0.83	10.37

NOTE: 1 rep each assembly (comparatives with wood studs)

Supplemental Tests by Foam Sheathing Coalition of Cladding Connections to Wood Studs (PEI, 2010b)

FSC TESTING -- wood furring to wood studs (wood-to-wood connections with and without gap):

					Average Load (lbs) per Fastener at Deflections:					Material Properties & Dimensions (averaged)							Predicted	RATIO	
Test ID	**Description**	**gap (foam) inches**	**Max Load per Fastener (lbs)**	**Defl. @ Max. Load (in.)**	**0.015"**	**0.125"**	**0.250"**	**0.375"**	**Failure Mode**	t1 (furring inches	t2 (stud) inches	G (furring sp. Grav.	G (stud) sp.grav.	d-min inches	d-max inches	Fyb (fastene psi	**NDS/TR12 5% offset yield valu**	**Predicted 5%offset to 0.015"**	**Safety Margin**
a1-screw	3/4" wood furring, (2) #8 wood screw, no foam	0	470	0.67	190	321	377	415	IIIs	0.75	1.25	0.44	0.46	0.106	0.165	204204	187	0.98	2.51
a2-screw	3/4" wood furring, (2) #8 wood screw, 1" EPS foam	1	428	1.116	60	119	169	215	IIIs	0.75	1.25	0.44	0.46	0.115	0.16	115000	79	1.32	5.42
a3-nail	3/4" wood furring, (2) 16d box (0.135"x3.5") nail, no foam	0	686	1.126	177	362	460	538	IIIs	0.75	2.75	0.44	0.46	0.134	0.134	107539	178	1.01	3.85
a4-nail	3/4" wood furring, (2) 16d box (0.135"x3.5") nail, 1" EPS	1	503	1.515	51	128	183	242	IIIm	0.75	1.75	0.44	0.46	0.134	0.134	107539	75	1.47	6.71
a5-nail	3/4" wood furring, (2) 0.135x4" foundry nail, 2" EPS	2	179	1.532	70	100	116	127	IIIm	0.75	1.25	0.44	0.46	0.135	0.135	120348	47	0.67	3.81
a6-nail	3/4" wood furring, (2) 0.135x6" foundry nails, 4" EPS	4	184	1.87	46	71	98	119	IIIm	0.75	1.25	0.44	0.46	0.135	0.135	120348	24	0.52	7.67
a7-lag	3/4" wood furring, (2) 1/4x2" lag screws, no foam	0	933	0.639	170	505	654	784	II	0.75	1.25	0.44	0.46	0.18	0.238	90000	309	1.82	3.02
a8-lag	3/4" wood furring, (2) 1/4x3" lag screws, 1" EPS	1	745	1.225	69	168	243	309	IV	0.75	1.25	0.44	0.46	0.18	0.238	88724	138	2.00	5.40
a9-lag	3/4" wood furring, (2) 1/4x4" lag screws, 2" EPS	2	649	1.536	91	161	209	248	IIIs	0.75	1.25	0.44	0.46	0.18	0.238	110122	93	1.02	6.98
a10-lag	3/4" wood furring, (2) 1/4x6" lag screws, 4" EPS	4	551	2.505	48	78	103	127	IIIs	0.75	1.25	0.44	0.46	0.18	0.238	78,654	45	0.94	12.24
b1-nail	3/8" wood furring, (2) 8d box (0.113x2.5") nails, no foam	0	221	0.238	98	204	219	221	IIIm	0.375	2.13	0.44	0.46	0.114	0.114	124512	117	1.19	1.89
b2-nail	3/8" wood furring, (2) 8d box (0.113x2.5") nails, 1/2" EPS	0.5	161	0.982	77	120	138	144	IV	0.375	1.63	0.44	0.46	0.114	0.114	124512	58	0.75	2.78
b3-nail	3/8" wood furring, (2) 8d box (0.113x2.5") nails, 1" EPS	1	125	1.036	39.5	67	86	94	IIIs	0.375	1.13	0.44	0.46	0.114	0.114	124512	36	0.91	3.47
b4-nail	3/8" wood furring, (2) 16d box (0.135x3.5") nails, 1" EPS	1	288	0.73	55	96	125	168	IIIs	0.375	2.13	0.44	0.46	0.134	0.134	107539	48	0.87	6.00
b5-nail	3/8" wood furring, (2) 16d (0.135x4") foundry nails, 2" EPS	2	155	1.121	56	77	95	104	IIIs	0.375	1.63	0.44	0.46	0.135	0.135	120348	30	0.54	5.17

APPENDIX B TO SECTION 4 - ICC MODEL BUILDING CODE PROPOSALS FOR 2012 IBS AND IRC

The following code proposals seek to amend the 2009 editions of the following model codes: International Building Code (IBC) and International Residential Code (IRC) available at www.iccsafe.org. These proposals are public comments modifying the original proposals, which include additional items as noted below in the public comments. The tables in each proposal with specific fastener requirements reflect the work conducted under this project. The other text is necessary to fit the tables into the ICC code formats. Similarly, the tables should be fit into a format consistent with the New York State Building and Residential Codes.

FS156-09/10 (PART 1) – IBC

202

Individual Consideration Agenda

This item is on the agenda for individual consideration because a public comment was submitted.

Public Comment:

Name: Jay H. Crandell, P.E. (ARES Consulting, representing Foam Sheathing Coalition) & Mark Nowak (representing Steel Framing Alliance)

Modify the proposal as follows (Only if AMPC is desired. If no modification is requested, enter your reason statement in "Commenter's Reason")**:**

1. *Revise Item 1 in original proposal as follows:*

1404.12 Foam plastic sheathing. Foam plastic sheathing shall comply with requirements for foam plastic insulation in Section 2603. When used as a water-resistive barrier, the foam plastic sheathing material and installation shall be approved in accordance with Section 1404.2. When used in exterior wall covering assemblies in accordance with Table 1405.18.1 of Section 1405.18.1, foam sheathing shall be identified by the trademarks of an *approved* testing and inspection agency in accordance with Section 1703 and 2603.2 indicating compliance with the wind pressure resistance requirements of Table 1405.18.1 where not already addressed in the applicable material standards.

2. *(No change to Item 2 of original proposal)*

3. Revise Item 3 of original proposal as follows:

1405.18 Foam plastic sheathing. Foam plastic sheathing used in exterior wall covering assemblies shall comply with this section, Section 2603, Chapter 13, and the foam sheathing manufacturer's approved installation instructions. Wall assemblies with foam plastic sheathing that are intended to serve as part of the lateral force resisting system of a structure shall be braced with approved materials designed to resist the in-plane shear force determined in accordance with Chapter 16. Wall assemblies with foam plastic sheathing attached to gravity load supporting members that require buckling restraint shall have such restraint provided by other approved materials. The use of foam plastic sheathing in accordance with this section shall not be permitted where the basic wind speed exceeds 110 mph.

~~**1405.18.1 Minimum thickness.** The thickness of foam plastic sheathing shall comply with Table 1405.18.1.~~

Exceptions:

1. Where foam plastic sheathing is covered with applied directly over or behind wall sheathing or other solid material substrate capable of separately resisting the required wind pressure, the limitations of Section 1405.18.1 and the basic wind speed limit of 110 mph Table 1405.18.1 shall not apply.
2. Where foam plastic sheathing is covered with cladding and applied directly over wall sheathing or other solid material, all capable of separately resisting the full design wind pressure, the limitations of Section 1405.18.1 and the basic wind speed limit of 110 mph shall not apply.

1405.18.1 Minimum thickness. The thickness of foam plastic sheathing shall comply with Table 1405.18.1. The components and cladding design wind pressure determined in accordance with Section 1609 shall not exceed the allowable wind pressure value in accordance with Table 1405.18.1.

(Delete and replace Table 1405.18.1 with the following):

TABLE 1405.18.1
ALLOWABLE WIND PRESSURE VALUE (PSF) FOR FOAM PLASTIC SHEATHING IN EXTERIOR WALL COVERING ASSEMBLIES[1]

Foam Plastic Sheathing Material[2]	Foam Sheathing Thickness (in.)	Allowable (ASD) Components and Cladding Design Wind Pressure (psf) (basic wind speed not to exceed 110 mph per Section 1405.18)			
		Walls with Interior Finish[3]		Walls without Interior Finish	
		16"oc framing	24"oc framing	16"oc framing	24"oc framing
EPS	¾"	21.8	NP	15.3	NP
	1"	38.8	19.4	27.2	13.6
	≥1-1/2"	89.0	39.5	62.3	27.7
Polyiso-cyanurate	½" (faced)	33.3	14.8	23.3	10.4
	¾" (faced)	56.4	25.1	39.5	17.6
	1" (faced)	67.5	30.0	47.2	21.0
	≥1-1/2" (faced)	77.4	34.4	54.1	24.1
XPS	½" (faced)	28.3	12.6	19.8	NP
	¾"	21.4	NP	15.0	NP
	1"	38.0	29.0	26.6	20.3
	≥1-1/2"	78.2	34.7	54.7	24.3

For SI: 1 inch = 25.4 mm, 1 pound per square foot (psf) = 0.0479 kPa.
NP = not permitted (allowable design wind pressure less than 10 psf)

1. Foam plastic sheathing panels shall be permitted to be oriented parallel or perpendicular to framing members.
2. Foam plastic sheathing shall meet or exceed the following material standards: Expanded Polystyrene (EPS) – ASTM C578 (Type II, min.1.35 lb/ft^3 density), Polyisocyanurate – ASTM C1289 (Type 1, min.), and extruded polystyrene (XPS) – ASTM C578 (Type X, min. 1.30 lb/ft^3 density). Where a "faced" product is indicated, a facer shall be provided on both faces of the foam plastic sheathing. Where facing is not indicated in the table, faced and unfaced foam plastic sheathing shall be permitted. For all foam plastic sheathing products, approved manufacturer data shall be permitted in lieu of the table requirements.
3. Interior finish shall be minimum 1/2-inch (12.7 mm) thick gypsum wall board or an approved product with equivalent or greater out-of-plane bending strength and stiffness.

1405.18.2 Siding attachment over foam sheathing. Siding shall be attached over foam sheathing in accordance with Section 1405.18.2.1, Section 1405.18.2.2, or an approved design. In no case shall the siding material be used in a manner that exceeds its application limits. When required by the basic wind speed and wind exposure applicability of Section 1706, wall cladding installation over foam sheathing shall be subject to special inspection in accordance with Section 1706.4.

Exception: Where the siding manufacturer has provided approved installation instructions for application over foam sheathing, those requirements shall apply.

1405.18.2.1 Direct siding attachment. Approved weather coverings installed directly over foam sheathing without separation by an air space shall comply with Table 1405.18.2.1 in regard to minimum fastening requirements nail diameter, penetration, and nail spacing and maximum foam sheathing thickness limitations to support siding dead load ~~for the applicable foam sheathing thickness and wind speed condition~~. The siding fastener and siding installation shall otherwise comply with Chapter 14, shall be capable of resisting all other applicable design loads determined in accordance with Chapter 16, and in no case shall result in a less stringent fastening requirement than required by Chapter 14 or the manufacturer's installation instructions for the specific siding material used.

Exception~~s~~:
~~1. For adhered masonry veneer, refer to Section 1405.10.~~
~~2. For vinyl siding, refer to Section 1405.14.~~
~~3.~~ For exterior insulation and finish systems, refer to Section 1408.

Replace Table 1405.18.2.1 and footnotes with the following:

TABLE 1405.18.2.1
SIDING MINIMUM FASTENING REQUIREMENTS
FOR DIRECT SIDING ATTACHMENT OVER FOAM PLASTIC SHEATHING
TO SUPPORT SIDING DEAD LOAD[1]

Siding Fastener Through Foam Sheathing into:	Siding Fastener Type and Minimum Size[2]	Siding Fastener Vertical Spacing (inches)	Maximum Foam Sheathing Thickness (inches)					
			16"oc Fastener Horizontal Spacing			24"oc Fastener Horizontal Spacing		
			Siding Weight:			Siding Weight:		
			3 psf	11 psf	25 psf	3 psf	11 psf	25 psf
Wood Framing (minimum 1-1/4 inch penetration)	0.113" diameter nail	6	4	3	1	4	2	0.75
		8	4	2	0.75	4	1.5	DR
		12	4	1.5	DR	3	0.75	DR
	0.120" diameter nail	6	4	3	1.5	4	2	0.75
		8	4	2	1	4	1.5	0.5
		12	4	1.5	0.5	3	1	DR
	0.131" diameter nail	6	4	4	1.5	4	3	1
		8	4	3	1	4	2	0.75
		12	4	2	0.75	4	1	DR
Steel Framing (minimum penetration of steel thickness + 3 threads)	#8 screw into 33 mil steel or thicker	6	3	3	1.5	3	2	DR
		8	3	2	0.5	3	1.5	DR
		12	3	1.5	DR	3	0.75	DR
	#10 screw into 33 mil steel	6	4	3	2	4	3	0.5
		8	4	3	1	4	2	DR
		12	4	2	DR	3	1	DR
	#10 screw into 43 mil steel or thicker	6	4	4	3	4	4	2
		8	4	4	2	4	3	1.5
		12	4	3	1.5	4	3	DR

For SI: 1 inch = 25.4 mm; 1 pound per square foot (psf) = 0.0479 kPa
DR = design required

4. Tabulated requirements are based on wood framing of Spruce-Pine-Fir or any wood species with a specific gravity of 0.42 or greater in accordance with AFPA/NDS and minimum 33 ksi steel for 33 mil and 43 mil steel and 50 ksi steel for 54 mil steel or thicker.
5. Nail fasteners shall comply with ASTM F1667, except nail length shall be permitted to exceed ASTM F1667 standard lengths. Self-drilling tapping screw fasteners for connection of siding to steel framing shall comply with the requirements of AISI S200. Specified fasteners in accordance with Chapter 1405 or the siding manufacturer's approved installation instructions shall meet all other requirements in ASTM F1667, AISI S200 or be otherwise approved for the intended application.

1405.18.2.2 Offset siding attachment. When an airspace separates the siding from direct contact with the foam plastic sheathing, the approved weather coverings shall be attached in accordance with Chapter 14 to minimum 1x3 wood or minimum 33 mil steel hat channel furring ~~strips~~ placed over the foam sheathing. Furring shall be attached through the foam sheathing to wall framing in accordance with Table 1405.18.2.2 in regard to minimum fastening requirements and maximum foam sheathing thickness limitations to support siding dead load. Furring and connections shall be separately designed to resist all other applicable loads determined in accordance with Chapter 16. When placed horizontally, wood furring ~~strips~~ shall be preservative treated wood in accordance with Section 2303.1.8 or naturally durable wood and fasteners shall be corrosion resistant in accordance with Section 2304.9.5. Steel hat channel furring shall have a minimum G60 galvanized coating.

Exception: Furring ~~strips~~ shall not be required over foam plastic sheathing behind anchored stone and masonry veneer installed in accordance with Section 1405.6. Veneer ties shall be installed on the surface of the foam plastic sheathing with fasteners of sufficient length to pass through the thickness of foam plastic sheathing and penetrate framing to provide required pull-out resistance determined in accordance with Chapter 16.

Replace Table 1405.18.2.2 and footnotes with the following:

TABLE 1405.18.2.2
FURRING MINIMUM FASTENING REQUIREMENTS FOR APPLICATION OVER FOAM PLASTIC SHEATHING TO SUPPORT SIDING DEAD LOAD[1,2]

Furring Material	Framing Member	Fastener Type and Minimum Size	Minimum Penetration into Wall Framing (inches)	Fastener Spacing in Furring (inches)	Maximum Thickness of Foam Sheathing (inches)					
					16"oc FURRING[4]			24"oc FURRING[4]		
					Siding Weight:			Siding Weight:		
					3 psf	11 psf	25 psf	3 psf	11 psf	25 psf
Minimum 1x Wood Furring[3]	Minimum 2x Wood Stud	0.120" diameter nail	1-1/4	8	4	4	1.5	4	2	1
				12	4	2	1	4	1.5	0.5
				16	4	2	0.5	4	1	DR
		0.131" diameter nail	1-1/4	8	4	4	2	4	3	1
				12	4	3	1	4	2	0.75
				16	4	2	0.75	4	1.5	DR
		#8 wood screw[5]	1	12	4	4	1.5	4	3	1
				16	4	3	1	4	2	0.5
				24	4	2	0.5	4	1	DR
		¼" lag screw[5]	1-1/2	12	4	4	3	4	4	1.5
				16	4	4	2	4	3	1
				24	4	3	1	4	2	0.5
Minimum 33mil Steel Hat Channel or Minimum 1x Wood Furring[3]	33 mil Steel Stud	#8 screw	Steel thickness + 3 threads	12	3	1.5	DR	3	0.5	DR
				16	3	1	DR	2	DR	DR
				24	2	DR	DR	2	DR	DR
		#10 screw	Steel thickness + 3 threads	12	4	2	DR	4	1	DR
				16	4	1.5	DR	3	DR	DR
				24	3	DR	DR	2	DR	DR
	43 mil or thicker Steel Stud	#8 Screw	Steel thickness + 3 threads	12	3	1.5	DR	3	0.5	DR
				16	3	1	DR	2	DR	DR
				24	2	DR	DR	2	DR	DR
		#10 screw	Steel thickness + 3 threads	12	4	3	1.5	4	3	DR
				16	4	3	0.5	4	2	DR
				24	4	2	DR	4	0.5	DR

For SI: 1" = 25.4 mm; 1 pound per square foot (psf) = 0.0479 kPa.
DR = design required

1. Table values are based on: (1) minimum ¾-inch (19.1 mm) thick wood furring and wood studs of Spruce-Pine-Fir or any softwood species with a specific gravity of 0.42 or greater per AFPA/NDS, (2) minimum 33 mil steel hat channel furring of 33 ksi steel, and (3) steel framing of indicated nominal steel thickness and minimum 33 ksi steel for 33mil and 43 mil steel and 50 ksi steel for 54 mil steel or thicker.
2. Nail fasteners shall comply with ASTM F1667, except nail length shall be permitted to exceed ASTM F1667 standard lengths. Self-drilling tapping screw fasteners for connection of siding to steel framing shall comply with the requirements of AISI S200. Specified fasteners in accordance with Chapter 1405 or the siding manufacturer's approved installation instructions shall meet all other requirements in ASTM F1667 or AISI S200 or be otherwise approved for the intended application.
3. Where the required siding fastener penetration into wood material exceeds ¾ inch (19.1 mm) and is not more than 1-1/2 inches (38.1 mm), a minimum 2x wood furring shall be used unless approved deformed shank siding nails or siding screws are used to provide equivalent withdrawal strength allowing connection to 1x wood furring.
4. Furring shall be spaced a maximum of 24"oc in a vertical or horizontal orientation. In a vertical orientation, furring shall be located over wall studs and attached with the required fastener spacing. In a horizontal orientation, furring strips shall be fastened at each stud intersection with a number of

fasteners equivalent to the required fastener spacing. In no case shall fasteners be spaced more than 24 inches (0.6 m) apart.

5. Lag screws shall be installed with a standard cut washer. Lag screws and wood screws shall be pre-drilled in accordance with AF&PA/NDS. Approved self-drilling screws of equal or greater shear and withdrawal strength shall be permitted without pre-drilling.

4. *(No change to Item 4 of original proposal)*

5. Revise Item 5 of original proposal as follows:

1405.14.2 Foam Plastic Sheathing. Vinyl siding used with foam plastic sheathing shall be installed in accordance with 1405.14.2.1, 1405.14.2.2, 1405.14.2.3.

> **Exception:** Where the foam plastic sheathing is applied directly over wood structural panels, fiberboard, gypsum sheathing, or other approved backing capable of independently resisting the design wind pressure, the vinyl siding shall be installed in accordance with 1405.14.1.

1405.14.2.1 Basic Wind Speed Not Exceeding 90 mph and Exposure Category B. Where the building mean roof height does not exceed 30 feet (9.1 m), the basic wind speed does not exceed 90 mph, the Exposure Category is B and gypsum wall board or equivalent is installed on the side of the wall opposite the foam plastic sheathing, the minimum siding fastener penetration into wood framing shall be 1-1/4 inches (32 mm) using minimum 0.120-inch diameter nail (shank) with a minimum 0.313-inch diameter head, and fastened 16 inches on center. The foam plastic sheathing shall comply with Section 1405.18.1 and shall not exceed a maximum thickness of 1.5 inches (38 mm) for a 0.120-inch diameter nail or 2.0 inches (51 mm) for a 0.135-inch diameter nail. Vinyl siding shall be permitted to be installed on furring strips in accordance with Section 1405.18.2.2 and the siding manufacturer's installation instructions when foam plastic sheathing thickness complies with Section 1405.18.1.

1405.14.2.2 Basic Wind Speed Exceeding 90mph or Exposure Categories C and D. Where the basic wind speed exceeds 90 mph or the Exposure Category is C or D, or all conditions of 1405.14.2.1 are not met, the adjusted design pressure rating for the assembly shall meet or exceed the wind loads required by Chapter 16. The design wind pressure rating of the vinyl siding for installation over solid sheathing as provided in the vinyl siding manufacturer's product specifications shall be adjusted for the following wall assembly conditions:

1. For wall assemblies with foam plastic sheathing on the exterior side and minimum ½-inch (12.7 mm) thick gypsum wall board or equivalent on the interior side of the wall, the vinyl siding's design wind pressure rating shall be multiplied by 0.39.
2. For wall assemblies with foam plastic sheathing on the exterior side and no gypsum wall board or equivalent on the interior side of the wall, the vinyl siding's design wind pressure rating shall be multiplied by 0.27.

> ~~**Exception:** The above adjustments shall not apply when vinyl siding is attached to wood furring strips installed over the foam plastic sheathing in accordance with Section 1405.18.2.2 and such installation is in accordance with the vinyl siding manufacturer's installation instructions.~~

1405.14.2.3 Manufacturer Specification. Where the vinyl siding manufacturer's product specifications provide an approved design wind pressure rating for installation over foam plastic sheathing, use of this design wind pressure rating shall be permitted and the siding shall be installed in accordance with the manufacturer's installation instructions.

6. *(No change to Item 6 of original proposal)*

Commenter's Reason:

This public comment responds to constructive criticism and supportive recommendations received at the first hearing. Every effort has been made to follow-up with the various interests and to respond with improvements to the original proposal. These improvements are also coordinated with a complimentary PC on FS156-09/10 Part 2 (IRC) as also requested by the IRC CDC, which approved the original proposal with a request for further refinements at Final Action. These refinements are coordinated and comprehensively made in this one PC for reasons addressed separately as follows:

Inclusion of Steel Framing

Tables 1405.18.2.1 and 1405.18.2.2 now include siding connections for use with light-frame cold-formed steel in addition to light-frame wood as requested at the first hearing. These are needed to provide siding connection solutions applicable to light-frame cold-formed steel construction to ensure coordination with IECC energy code requirements for this type of construction (as mentioned in the IBC-S committee's reason for disapproval). The Steel Framing Alliance (SFA), American Iron and Steel Institute (AISI), and the Foam Sheathing Coalition (FSC) have worked together toward this end.

The original proposal included connection solutions for attachment of siding over foam sheathing only for wood framing. The scope of the original proposal was not otherwise limited to wood framing (i.e., requirements in Table 1405.18.1 of the original proposal are applicable to both wood and steel framing). The IRC committee approved the original FS156-09/10 proposal, but also expressed concern to "work with industry and bring the needed improvement back to the Final Action."

Steel framing was not addressed in the original proposal only because test data was not available at that time to justify appropriate solutions. Subsequently, the steel industry, together with New York State Energy Research and Development Authority (NYSERDA), has conducted a testing program to provide justification to the solutions proposed in this PC. A report on this testing will be made available at the Final Action hearing and, as soon as available, by request to the proponent (Mark Nowak, SFA, mnowak@steelframing.org). These tests provide the necessary performance data for appropriately designing siding connections to steel framing that spans through a thickness of foam sheathing.

These proposed provisions for light-frame cold-formed steel construction are not only coordinated with ICC energy code requirements, but they are necessary to ensure that foam insulation requirements as required by the ICC energy code are implemented in a structurally sound manner. Support of this PC is urged.

Inclusion of Additional Siding Weight Categories:

The original proposal was based on a minimum 11 psf siding dead load (for siding attachment requirements over foam sheathing). While various siding manufacturers supported the original proposal (or remained neutral), several expressed the desire to be included, such as the Masonry Veneer Manufacturers Association. Thus, a 25 psf siding weight category and connection requirements have been included in this PC. This also required inclusion of a 3 psf siding weight category such that the lighter weight sidings would not be unduly penalized by basing the table only on heavier siding types.

Simplification, Clarification and Editorial Improvements:

- Content from table footnotes moved into tables for visual clarity and ease of access.
- Removed confusing wind speed requirements from siding attachment table otherwise intending to address connection requirements for support of siding dead load and limit foam thickness. The text is clarified to more explicitly require that the siding attachment be separately designed to resist other loading conditions, including wind.
- Adjusted fastener sizes to be compatible with pneumatic fasteners at request of ISANTA
- Various editorial improvements to language, table headings, etc.

Additional technical justification for siding connections over foam sheathing

The FSC has also done additional testing of siding over foam sheathing connection assemblies for attachments to wood framing. These tests add further confirmation of the adequacy of the proposed siding attachment requirements for wood framing and support of siding weight. It also confirms that siding deflections will be limited to less than 0.015" as commonly used as a design basis for wood connections. A report documenting this testing will also be made available at the final action hearing and will be posted at www.foamsheathing.org as soon as available.

Strengthened QC requirements for foam sheathing wind pressure resistance properties

One of the concerns raised at the first code development hearing on FS156 was related to having assurance that foam sheathing products meet the wind pressure performance requirements upon which the proposal (namely Table 1405.18.1) is based. This public comment addresses that concern by clarifying implementation of a code-recognized "approved agency" approach that already exists and is commonly used for foam sheathing and other products.

First, 2009 IBC Section 2603.2 gives foam plastic insulation requirements for use of an approved agency and labeling to ensure end use complies with code requirements as follows:

> **2603.2 Labeling and identification.** Packages and containers of foam plastic insulation and foam plastic insulation components delivered to the job site shall bear the *label* of an *approved agency* showing the manufacturer's name, product listing, product identification and information sufficient to determine that the end use will comply with the code requirements.

Second, 2009 IBC Section 2603.5.4 provides an example of product performance criteria (test method and minimum performance indices), which the "approved agency" must consider in meeting the requirements of Section 2603.2:

> **2603.5.4 Flame spread and smoke-developed indexes.** Foam plastic insulation, exterior coatings and facings shall be tested separately in the thickness intended for use, but not to exceed 4 inches (102 mm), and shall each have a flame spread index of 25 or less and a smoke-developed index of 450 or less as determined in accordance with ASTM E 84 or UL 723.

Third, the Approved Agency is defined in Sections 202 and 1702.1 of the 2009 IBC as follows:

> **APPROVED AGENCY.** An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been *approved*.

And, the responsibilities of the Approved Agency include:

> **1703.1 Approved agency.** An *approved agency* shall provide all information as necessary for the *building official* to determine that the agency meets the applicable requirements.
>
> **1703.1.1 Independence.** An *approved agency* shall be objective, competent and independent from the contractor responsible for the work being inspected. The agency shall also disclose possible conflicts of interest so that objectivity can be confirmed.
>
> **1703.5 Labeling.** Where materials or assemblies are required by this code to be *labeled*, such materials and assemblies shall be *labeled* by an *approved agency* in accordance with Section 1703. Products and materials required to be labeled shall be labeled in accordance with the procedures set forth in Sections 1703.5.1 through 1703.5.3.

This approach is also used for other materials such as:

> **2303.1.4 Wood structural panels.** Wood structural panels, when used structurally (including those used for siding, roof and wall sheathing, subflooring, diaphragms and built-up members), shall conform to the requirements for their type

> in DOC PS 1 or PS 2. Each panel or member shall be identified for grade and glue type by the trademarks of an *approved* testing and grading agency. Wood structural panel components shall be designed and fabricated in accordance with the applicable standards listed in Section 2306.1 and identified by the trademarks of an *approved* testing and inspection agency indicating conformance with the applicable standard. In addition, wood structural panels, when permanently exposed in outdoor applications, shall be of exterior type, except that wood structural panel roof sheathing exposed to the outdoors on the underside is permitted to be interior type bonded with exterior glue, Exposure 1.

Additionally, a Fabricated Item is defined as follows:

> **FABRICATED ITEM.** Structural, load-bearing or lateral load-resisting assemblies consisting of materials assembled prior to installation in a building or structure, or subjected to operations such as heat treatment, thermal cutting, cold working or reforming after manufacture and prior to installation in a building or structure. Materials produced in accordance with standard specifications referenced by this code, such as rolled structural steel shapes, steel-reinforcing bars, masonry units, and wood structural panels or in accordance with a standard, listed in Chapter 35, which provides requirements for quality control done under the supervision of a third-party quality control agency shall not be considered "fabricated items."

The above described "approved agency" process has shown itself effective and this public comment merely clarifies the application of this process to assure the structural properties (wind pressure resistance) of foam sheathing align with the basis of the proposed end-use requirements and limitations. The minimum performance requirements are based on a representative sample of currently manufactured products of each type as reported by the NAHB Research Center, Inc. (report available at www.foamsheathing.org). Support for this PC is urged.

Strengthened Scope Limitations on Foam Sheathing Applications

At the request of the insurance industry, a 110 mph wind speed limit has also been implemented in this proposal for foam sheathing. In addition, wind pressure requirements have been strengthened to require use of negative pressure values in all cases, even when siding is placed over foam sheathing and the siding is separately capable of resisting the full negative design wind pressure.

These provisions are needed for the above reasons, provide improvements for appropriate use of foam sheathing, and provide needed solutions for coordination with the energy code requirements. Again, your approval as modified is urged.

FS156-09/10 (Part 2) – IRC
202

Individual Consideration Agenda

This item is on the agenda for individual consideration because a public comment was submitted.

Public Comment:

Name: Jay H. Crandell, P.E. (ARES Consulting, rep. FSC) and Mark Nowak (rep. SFA)

Modify the proposal as follows (Only if AMPC is desired. If no modification is requested, enter your reason statement in "Commenter's Reason")**:**

1. Revise Item 1 of original proposal as follows:

R703.3 Foam plastic sheathing. Foam plastic sheathing used in exterior wall covering assemblies shall comply with this section, Section R316, Chapter 11 and the manufacturer's installation instructions. Light frame wood and cold-formed steel braced wall lines including foam plastic sheathing shall be braced with approved materials in accordance with Chapter 6. Where lateral buckling restraint of light-frame wood and cold-formed steel studs also is required in Chapter 6, foam sheathing shall not be permitted to provide the required lateral buckling restraint. When used in exterior wall covering assemblies in accordance with Table 703.3.1 of Section R703.3.1, foam sheathing shall be identified by the trademarks of an *approved* testing and inspection agency in accordance with Section 316.2 indicating compliance with the wind pressure resistance requirements of Table R703.3.1 where not already addressed in the applicable material standards. The use of foam plastic sheathing in accordance with this section shall not be permitted where the basic wind speed exceeds 110 mph.

~~**R703.3.1 Minimum thickness.** The thickness of foam plastic sheathing shall comply with Table R703.3.1.~~

Exceptions:

1. Where foam plastic sheathing is covered with ~~applied directly over or behind~~ wall sheathing or other solid material ~~substrate~~ capable of separately resisting the required wind pressure, the limitations of Section R703.3.1 and the basic wind speed limit of 110 mph ~~Table 703.3.1~~ shall not apply.
2. Where foam plastic sheathing is covered with cladding and applied directly over wall sheathing or other solid material, all capable of separately resisting the full design wind pressure, the limitations of Section R703.3.1 and the basic wind speed limit of 110 mph shall not apply.

R703.3.1 Minimum thickness. The thickness of foam plastic sheathing shall comply with Table R703.3.1. The components and cladding design wind pressure determined in accordance with Table R301.2(2) shall not exceed the allowable wind pressure value in accordance with Table R703.3.1.

(Delete and replace Table R703.3.1 as follows):

TABLE R703.3.1
ALLOWABLE WIND PRESSURE VALUE (PSF) FOR FOAM PLASTIC SHEATHING IN EXTERIOR WALL COVERING ASSEMBLIES[1]

Foam Plastic Sheathing Material[2]	Foam Sheathing Thickness (in.)	Allowable (ASD) Components and Cladding Design Wind Pressure (psf) (basic wind speed not to exceed 110 mph per Section R703.3)			
		Walls with Interior Finish[3]		Walls without Interior Finish	
		16"oc framing	24"oc framing	16"oc framing	24"oc framing
EPS	¾"	21.8	NP	15.3	NP
	1"	38.8	19.4	27.2	13.6
	≥1-1/2"	89.0	39.5	62.3	27.7
Polyiso-cyanurate	½" (faced)	33.3	14.8	23.3	10.4
	¾" (faced)	56.4	25.1	39.5	17.6
	1" (faced)	67.5	30.0	47.2	21.0
	≥1-1/2" (faced)	77.4	34.4	54.1	24.1
XPS	½" (faced)	28.3	12.6	19.8	NP
	¾"	21.4	NP	15.0	NP
	1"	38.0	29.0	26.6	20.3
	≥1-1/2"	78.2	34.7	54.7	24.3

For SI: 1 inch = 25.4 mm, 1 pound per square foot (psf) = 0.0479 kPa.
NP = not permitted (allowable design wind pressure less than 10 psf)

3. Foam plastic sheathing panels shall be permitted to be oriented parallel or perpendicular to framing members.
4. Foam plastic sheathing shall meet or exceed the following material standards: Expanded Polystyrene (EPS) – ASTM C578 (Type II, min.1.35 lb/ft^3 density), Polyisocyanurate – ASTM C1289 (Type 1, min.), and extruded polystyrene (XPS) – ASTM C578 (Type X, min. 1.30 lb/ft^3 density). Where a "faced" product is indicated, a facer shall be provided on both faces of the foam plastic sheathing. Where facing is not indicated in the table, faced and unfaced foam plastic sheathing shall be permitted. For all foam plastic sheathing products, approved manufacturer data shall be permitted in lieu of the table requirements.
3. Interior finish shall be minimum 1/2-inch (12.7 mm) thick gypsum wall board or an approved product with equivalent or greater out-of-plane bending strength and stiffness.

R703.3.2 Siding attachment over foam sheathing. Siding shall be attached over foam sheathing in accordance with Section R703.3.2.1, Section R703.3.2.2, or an approved design. In no case shall the siding material be used in a manner that exceeds its application limits.

> **Exception:** Where the siding manufacturer has provided installation instructions for application over foam sheathing, those requirements shall apply.

R703.3.2.1 Direct siding attachment. Siding installed directly over foam sheathing without separation by an air space shall comply with Table R703.3.2.1 in regard to minimum fastening requirements ~~nail diameter, penetration, and nail spacing~~ and maximum foam sheathing thickness limitations to support siding dead load. ~~for the applicable foam sheathing thickness and wind speed condition~~. The siding fastener and siding installation shall otherwise comply with Section 703.4 and Table R703.4 and in no case shall result in a less stringent fastening requirement than required by Section R703.4 or the manufacturer's installation instructions for the specific siding material used.

Exception~~s~~:
~~1. For adhered masonry veneer, refer to Section 1405.10.~~
~~2. For vinyl siding, refer to Section 1405.14.~~
~~3.~~ For exterior insulation and finish systems, refer to Section 1408.

(Delete and replace Table R703.3.2.1 as follows):

TABLE R703.3.2.1
SIDING MINIMUM FASTENING REQUIREMENTS
FOR DIRECT SIDING ATTACHMENT OVER FOAM PLASTIC SHEATHING
TO SUPPORT SIDING WEIGHT[1]

Siding Fastener Through Foam Sheathing into:	Siding Fastener Type and Minimum Size[2]	Siding Fastener Vertical Spacing (inches)	Maximum Foam Sheathing Thickness (inches)					
			16”oc Fastener Horizontal Spacing			24”oc Fastener Horizontal Spacing		
			Siding Weight:			Siding Weight:		
			3 psf	11 psf	25 psf	3 psf	11 psf	25 psf
Wood Framing (minimum 1-1/4 inch penetration)	0.113” diameter nail	6	4	3	1	4	2	0.75
		8	4	2	0.75	4	1.5	DR
		12	4	1.5	DR	3	0.75	DR
	0.120” diameter nail	6	4	3	1.5	4	2	0.75
		8	4	2	1	4	1.5	0.5
		12	4	1.5	0.5	3	1	DR
	0.131” diameter nail	6	4	4	1.5	4	3	1
		8	4	3	1	4	2	0.75
		12	4	2	0.75	4	1	DR
Steel Framing (minimum penetration of steel thickness + three threads)	#8 screw into 33 mil steel or thicker	6	3	3	1.5	3	2	DR
		8	3	2	0.5	3	1.5	DR
		12	3	1.5	DR	3	0.75	DR
	#10 screw into 33 mil steel	6	4	3	2	4	3	0.5
		8	4	3	1	4	2	DR
		12	4	2	DR	3	1	DR
	#10 screw into 43 mil steel or thicker	6	4	4	3	4	4	2
		8	4	4	2	4	3	1.5
		12	4	3	1.5	4	3	DR

For SI: 1 inch = 25.4 mm; 1 pound per square foot (psf) = 0.0479 kPa.
DR = design required:

1. Tabulated requirements are based on wood framing of Spruce-Pine-Fir or any wood species with a specific gravity of 0.42 or greater in accordance with AFPA/NDS and minimum 33 ksi steel for 33mil and 43 mil steel and 50 ksi steel for 54 mil steel or thicker.
2. Nail fasteners shall comply with ASTM F1667, except nail length shall be permitted to exceed ASTM F1667 standard lengths. Self-drilling tapping screw fasteners for connection of siding to steel framing shall comply with the requirements of AISI S230. Specified fasteners in accordance with Section R703.4 or the siding manufacturer’s approved installation instructions shall meet all other requirements in ASTM F1667, AISI S230 or be otherwise approved for the intended application.

R703.3.2.2 Offset siding attachment. When an airspace separates the siding from direct contact with the foam plastic sheathing, the siding shall be attached in accordance with Section R703.4 and Table R703.4 to minimum 1x3 wood or minimum 33 mil steel hat channel furring ~~strips~~ placed over the foam sheathing. Furring shall be attached through the foam sheathing to wall framing in accordance with Table R703.3.2.2 in regard to minimum fastening requirements and maximum foam sheathing thickness limitations to support siding dead load. The components and cladding design wind pressure determined in accordance with Table R301.2(2) shall not exceed the allowable design wind pressure value in accordance with Table R703.3.2.2. For 25 psf siding weight in accordance with Table R703.3.2.2, the Seismic Design Category shall not exceed D_0 for 16”oc furring or C for 24”oc furring. When placed horizontally, wood furring ~~strips~~ shall be preservative treated wood or naturally durable wood and fasteners shall be corrosion resistant in accordance with Section R317. Steel hat channel furring shall have a minimum G60 galvanized coating.

> **Exception:** Furring ~~strips~~ shall not be required over foam plastic sheathing located behind anchored stone and masonry veneer installed in accordance with Section R703.7. Veneer ties shall be installed in accordance with Section R703.7.4.1.

(Delete and replace Table R703.3.2.2 as follows):

TABLE R703.3.2.2
FURRING MINIMUM FASTENING REQUIREMENTS
FOR APPLICATION OVER FOAM PLASTIC SHEATHING
TO SUPPORT SIDING WEIGHT[1,2]

Furring Material	Framing Member	Fastener Type and Minimum Size	Minimum Penetration into Wall Framing (inches)	Fastener Spacing in Furring (inches)	Maximum Thickness of Foam Sheathing (inches) 16"oc Furring[4] Siding Weight: 3 psf	16"oc Furring[4] 11 psf	16"oc Furring[4] 25 psf	24"oc Furring[4] Siding Weight: 3 psf	24"oc Furring[4] 11 psf	24"oc Furring[4] 25 psf	Allowable Design Wind Pressure (psf) 16"oc Furring	Allowable Design Wind Pressure (psf) 24"oc Furring
Minimum 1x Wood Furring[3]	Minimum 2x Wood Stud	Nail (0.120" shank; 0.271" head)	1-1/4	8	4	4	1.5	4	2	1	42.6	28.4
				12	4	2	1	4	1.5	0.5	28.4	18.9
				16	4	2	0.5	4	1	DR	21.3	14.2
		Nail (0.131" shank; 0.281" head)	1-1/4	8	4	4	2	4	3	1	46.5	31.0
				12	4	3	1	4	2	0.75	31.0	20.7
				16	4	2	0.75	4	1.5	DR	23.3	15.5
		#8 wood screw[5]	1	12	4	4	1.5	4	3	1	98.9	66.0
				16	4	3	1	4	2	0.5	74.2	49.5
				24	4	2	0.5	4	1	DR	35.1	23.4
		¼" lag screw[5]	1-1/2	12	4	4	3	4	4	1.5	140.4	93.6
				16	4	4	2	4	3	1	79.0	52.7
				24	4	3	1	4	2	0.5	35.1	23.4
Minimum 33mil Steel Hat Channel or Minimum 1x Wood Furring[3]	33 mil Steel Stud	#8 screw (0.285" head)	Steel thickness +3 threads	12	3	1.5	DR	3	0.5	DR	52.9	35.3
				16	3	1	DR	2	DR	DR	39.7	26.5
				24	2	DR	DR	2	DR	DR	26.5	17.6
		#10 screw (0.333" head)	Steel thickness +3 threads	12	4	2	DR	4	1	DR	62.9	41.9
				16	4	1.5	DR	3	DR	DR	47.1	31.4
				24	3	DR	DR	2	DR	DR	31.4	21.0
	43 mil or thicker Steel Stud	#8 screw (0.285" head)	Steel thickness +3 threads	12	3	1.5	DR	3	0.5	DR	69.0	46.0
				16	3	1	DR	2	DR	DR	51.8	34.5
				24	2	DR	DR	2	DR	DR	34.5	23.0
		#10 screw (0.333" head)	Steel thickness +3 threads	12	4	3	1.5	4	3	DR	81.9	54.6
				16	4	3	0.5	4	2	DR	61.5	41.0
				24	4	2	DR	4	0.5	DR	35.1	23.4

For SI: 1" = 25.4 mm; 1 pound per square foot (psf) = 0.0479 kPa. DR = design required

7. Table values are based on: (1) minimum ¾-inch (19.1 mm) thick wood furring and wood studs of Spruce-Pine-Fir or any softwood species with a specific gravity of 0.42 or greater per AFPA/NDS, (2) minimum 33 mil steel hat channel furring of 33 ksi steel, and (3) steel framing of indicated nominal steel thickness and minimum 33 ksi steel for 33mil and 43 mil steel and 50 ksi steel for 54 mil steel or thicker. Steel hat channel shall have a minimum 7/8-inch (22.2 mm) depth.
8. Nail fasteners shall comply with ASTM F1667, except nail length shall be permitted to exceed ASTM F1667 standard lengths. Self-drilling tapping screw fasteners for connection of siding to steel framing shall comply with the requirements of AISI S230. Specified fasteners in accordance with Section R703.4 or the siding manufacturer's approved installation instructions shall meet all other requirements in ASTM F1667 or AISI S230 or be otherwise approved for the intended application.
9. Where the required siding fastener penetration into wood material exceeds ¾ inch (19.1 mm) and is not more than 1-1/2 inches (38.1 mm), a minimum 2x wood furring shall be used unless approved deformed shank siding nails or siding screws are used to provide equivalent withdrawal strength allowing connection to 1x wood furring.
10. Furring shall be spaced a maximum of 24"oc in a vertical or horizontal orientation. In a vertical orientation, furring shall be located over wall studs and attached with the required fastener spacing. In a horizontal orientation, furring strips shall be fastened at each stud intersection with a number of fasteners equivalent to the required fastener spacing. In no case shall fasteners be spaced more than 24 inches (0.6 m) apart.
11. Lag screws shall be installed with a standard cut washer. Lag screws and wood screws shall be pre-drilled in accordance with AF&PA/NDS. Approved self-drilling screws of equal or greater shear and withdrawal strength shall be permitted without pre-drilling.

(NO CHANGES TO REMAINDER OF ORIGINAL PROPOSAL)

Commenter's Reason:

While the original proposal was approved as submitted, IRC CDC recommended further refinements at Final Action. Every effort has been made to follow-up with the various interests and to respond with improvements to the original proposal, even though approved as submitted. The improvements in this PC are also coordinated with a complimentary PC on FS156-09/10 Part1 (IBC). These refinements are coordinated in this one PC for reasons addressed separately as follows:

Inclusion of Steel Framing

Tables R703.2.1 and R703.2.2 now include siding connections for use with light-frame cold-formed steel siding in addition to light-frame wood as requested at the first hearing. These are needed to provide siding connection solutions applicable to light-frame cold-formed steel construction to ensure coordination with IRC Ch11 and IECC energy code requirements for this type of construction. The Steel Framing Alliance (SFA), American Iron and Steel Institute (AISI), and the Foam Sheathing Coalition (FSC) have worked together toward this end.

The original proposal included connection solutions for attachment of siding over foam sheathing only for wood framing. But, the scope of the original proposal was not otherwise limited to wood framing (i.e., requirements in Table 1405.18.1 of the original proposal are applicable to both wood and steel framing). The IRC committee approved the original FS156-09/10 proposal, but also expressed concern to "work with industry and bring the needed improvement back to the Final Action."

Steel framing was not addressed in the original proposal only because test data was not available at that time to justify appropriate solutions. Subsequently, the steel industry, together with New York State Energy Research and Development Authority (NYSERDA), has conducted a testing program to provide justification to the solutions proposed in this PC. A report on this testing will be made available at the Final Action hearing and, as soon as available, by request to the proponent (Mark Nowak, SFA, mnowak@steelframing.org). These tests provide the necessary performance data for appropriately designing siding connections to steel framing that span through a thickness of foam sheathing.

These proposed provisions for light-frame cold-formed steel construction are not only coordinated with ICC energy code requirements, but they are necessary to ensure that foam insulation requirements as required by the ICC energy code are implemented in a structurally sound manner. Support of this PC is urged.

Inclusion of Additional Siding Weight Categories:

The original proposal was based on a minimum 11 psf siding dead load (for siding attachment requirements over foam sheathing). While various siding manufacturers supported the original proposal (or remained neutral), several expressed the desire to be included, such as the Masonry Veneer Manufacturers Association. Thus, a 25 psf siding weight category and connection requirements have been included in this PC. This also required inclusion of a 3 psf siding weight category such that the lighter weight sidings would not be unduly penalized by basing the table only on heavier siding types.

Simplification, Clarification and Editorial Improvements:

- Content from table footnotes moved into tables for visual clarity and ease of access.
- Removed confusing wind speed requirements from siding attachment table otherwise intending to provide minimum connections for support of siding dead load only and limit foam thickness accordingly. The text is clarified to more explicitly require that the siding attachment be separately designed to resist wind loads.
- Adjusted fastener sizes to be compatible with pneumatic fasteners at request of ISANTA
- Various editorial improvements to language, table headings, etc.

Additional technical justification for siding and furring connections over foam sheathing

The FSC has also funded additional testing of siding over foam sheathing connection assemblies for attachments to wood framing. These tests add further confirmation of the adequacy of the proposed siding attachment requirements for wood framing. It also confirms that siding deflections will be limited to less than 0.015" as commonly used as a design basis for wood connections. A report documenting this testing will also be made available at the final action hearing and will be posted at www.foamsheathing.org as soon as available.

Strengthened QC requirements for foam sheathing wind pressure resistance properties

One of the concerns raised at the first code development hearing on FS156 was related to having assurance that foam sheathing products meet the wind pressure performance requirements upon which the proposal (namely Table R703.3.1) is based. This public comment addresses that concern by clarifying implementation a code-recognized "approved agency" approach that already exists and is commonly used for foam sheathing and other products. The "approved agency" process has shown itself effective and this public comment merely clarifies the application of this process to assure the structural properties (wind pressure resistance) of foam sheathing align with the basis of the proposed end-use requirements and limitations. The minimum performance requirements are based on a representative sample of currently manufactured products of each type as reported by the NAHB Research Center, Inc. (report available at www.foamsheathing.org).

Strengthened Scope Limitations on Foam Sheathing Applications

At the request of the insurance industry, a 110 mph wind speed limit has also been implemented in this proposal for foam sheathing. In addition, wind pressure requirements have been strengthened to require use of negative pressure values in all cases, even when siding is placed over foam sheathing and the siding is separately capable of resisting the full negative design wind pressure.

These provisions are needed for the above reasons, provide improvements for appropriate use of foam sheathing, and provide needed solutions for coordination with the energy code requirements. Again, your approval as modified is urged.

APPENDIX C TO SECTION 4 - TEST LAB REPORT (PEI, 2010A)

Progressive Engineering Inc.

NEWPORT VENTURES, INC.

Evaluation of Siding Attachment Methods
using Various Materials

1/28/2010

This test report contains eighty-six (86) pages, including the cover sheet. Any additions to, alterations of, or unauthorized use of excerpts from this report are expressly forbidden.

2009-1407

58640 State Road 15 - Goshen, IN 46528
Phone: 574-533-0337 - Fax: 574-533-9736
www.p-e-i.com

1. **TITLE**

Evaluation of Siding Attachment Methods using Various Materials

2. **OBJECTIVE**

1) To determine the withdrawal capacity of various fasteners in 7/16" and 3/4" OSB.
2) To determine the shear capacity of various assemblies simulating siding or furring strips attached directly to framing (steel or wood), to OSB sheathing, or varying thicknesses of EPS foam board.
3) To determine the long-term creep characteristics of shear assemblies tested in Objective 2.

The above objectives were based on the Newport Ventures test plan.

This test report pertains only to the specimens tested. It remains the sole responsibility of the manufacturer to provide a product consistent to that which was tested.

3. **TESTED FOR**

Newport Ventures, Inc.
3760 Tanglewood Lane
Davidsonville, MD 21035

4. **TESTING ORGANIZATION**

Progressive Engineering Inc.
58640 State Road 15
Goshen, IN 46528
www.p-e-i.com

See IAS Evaluation Report No. TL-178 for ISO 17025 Accreditation.

5. **TESTING PERSONNEL**

Laboratory Manager	- Jason R. Holdeman	Jason R. H
Technician	- Jacob Bontrager	
Technician	- Chris Stutzman	

6. **REFERENCE STANDARDS**

ASTM D1761-06 - Standard Test Methods for Mechanical Fasteners in Wood

7. TESTING EQUIPMENT

- PEI Data Acquisition System (*PEI* #566)
- Dial Indicators (*PEI* #574 and *PEI* #676)
- Linear Transducer (*PEI* # 653)
- Load Cell (*PEI* # 122)

8. TEST SPECIMEN

A. Siding / Furring Strip

- Steel Hat Channel - Part No. DWC-7/8 20, manufactured by Dietrich Industries.

- Wood Siding / Furring Strip - 1x4 Spruce-Pine-Fir lumber, ungraded. 3/8" siding simulated by reducing the 1x4 thickness to 3/8" at the fastener locations using a 2" diameter boring drill.

B. Framing

- Wood - 2x4 Spruce-Pine-Fir, Stud Grade lumber

- Steel - 3.5" deep x 1-5/8" flange with 1/2" return leg, 33 mil or 54 mil thickness. Part No. CSJ20 and CSJ16 manufactured by Dietrich Industries.

C. Foam Board

- Expanded Polystyrene (EPS) boards 48" x 96" with thicknesses of 1", 2", and 4". (Type II, 1.35 pcf) Material purchased at Keypac Industries.

D. Sheathing

- 7/16" OSB Rated Sheathing, 24/16, DEC 09 mfd. by LP.

- 23/32" OSB Rated STURD-I-FLOOR, 24 oc, OCT-09 mfd. by GP.

8. TEST SPECIMEN (con't)

E. Fasteners

1. Nails

- 7d x 2-1/4" long Box Nails, Bright, Smooth. Manufacturer unknown.
- 16d x 3-1/2" long Common Nails, Bright, Smooth. Manufactured by X-Cell Fasteners.
- 16d x 3-1/2" long Box Nails, Hot Dipped Gavanized. Manufactured by Grip Rite, Part No. 16HGBX1. Galvanized Layer removed for testing.
- 10 Ga. x 6" long Foundry Nails, Bright, Smooth. Manufactured by Maze Nails, Part No. XFN600135.

2. Screws

- #8 x 3" long standard wood screw. Manufactured by Fastenal, Part No. 30144.
- #8 x 2" long standard wood screw. Manufactured by Fastenal, Part No. 1129733.
- 1/4" x 2" long standard lag screw. Manufactured by Fastenal, Part No. 1122061.
- 1/4" x 3" long standard lag screw. Manufactured by Fastenal, Part No. 1122065.
- 1/4" x 4" long standard lag screw. Manufactured by Hillman, Part No. HS14ZP4.
- 1/4" x 6" long standard lag screw. Manufactured by Fastenal, Part No. 1122075.
- 1/4" x 7" long standard lag screw. Manufactured by Fastenal, Part No. 22077.
- #8 x 2-3/8" bugle-head, self-drilling/tapping screws. Manufactured by Grabber, Part No. 30SRG.
- #10 x 3-1/2" bugle-head, self-drilling/tapping screws. Manufactured by Grabber, Part No. B10350SDL2RG.
- #10 x 5" bugle-head, self-drilling/tapping screws. Manufactured by Grabber, Part No. B10500SDRG.
- 1/4" Flat Washers. Manufactured by Hillman, Part No. 490687. The average measured inner diameter was .285". The average measured outer diameter was .623". The average measured thickness was .053".

A sufficient quantity of each of the materials listed were purchased to perform all of the tests. Samples were taken for each material to verify critical properties (as defined in the Newport Ventures Test Plan dated 1/10/10) and this information can be found in the Appendix section of this report.

9. TEST SPECIMEN CONSTRUCTION

A. Fastener Withdrawal Test

The sheathing was cut into 3" x 6" pieces. A hole was predrilled thru the center of the 3" x 6" area for ALL of the SCREW Withdrawal samples tested. The hole was 50% of the root diameter. A portion of the NAIL Withdrawal samples were not predrilled, as requested by the client. The NAIL Withdrawal samples labeled "Predrilled" had a hole 60% of the shank diameter predrilled thru the center of the 3" x 6" area. ALL of the fasteners were inserted into the OSB with a minimum distance of .5" from the underside of the fastener head to the sheathing surface. Care was taken to ensure that the long-axis of the fastener was perpendicular to the sheathing surface and minimal damage occurred to the sheathing during the insertion of the fastener. (Nails did cause breakout on the backside.)

B. Assembly Shear Tests

Each of the assemblies were constructed using the prescriptive method provided in Newport Ventures Test Plan dated 1/10/10. An assembly consisted of a 12" x 16" piece of foam and/or OSB, in some cases a 16" long piece of framing material, and a 20" long siding/furring strip. The siding/furring strip was oriented parallel with the 16" dimension of the backing material and flush on one end. Fasteners were inset 4" from each end of the 16" dimension, resulting in a 8" separation. The assembly construction is outlined on each data page. All nails were hand-driven, by a PEI technician, such that the head of the fastener was tight to the siding/furring strip. In the case of screws or lags, they were driven using pnuematic or electric tools until the head was tight to the siding/furring strip or flush with the siding/furring strip for buglehead or wood screws. The fasteners were tightened or hammered such that the siding/furring strip caused minimal indentation to the foam, with no voids between layers.

C. Long-Term Creep Tests

Each of the assemblies were constructed using the prescriptive method provided in Newport Ventures Test Plan dated 1/10/10. The assembly construction is outlined on each data page and utilized the same guidelines stated in Section 9B of this report.

10. TEST SET-UP

A. Fastener Withdrawal Test

The sample was positioned in a test fixture as shown in Figure 1 of ASTM D1761 . A loading fixture was slid under the fastener head.

B. Assembly Shear Tests

The sample was positioned vertically on a rigid test platform such that the siding/furring strip was not over the support and the non-flush end was at the top. (The support platform was adjusted to accommodate the various assembly depths.) The 12" x 16" backing material portion of the test sample was clamped to a rigid member located opposite the siding/furring strip. A linear transducer was connected to the siding furring strip at one end and to a formed steel plate that was clamped or fastened to the supporting member (i.e. frame, sheathing). The linear transducer was oriented parallel with the long-axis of the siding/furring strip. The top of the siding/furring strip was reinforced with a steel plate or angle to prevent splitting or crushing at the load point. A load cell was positioned over the top of the siding/furring strip and was attached to a fixed crosshead in the test machine.

C. Long-Term Creep Tests

The sample was positioned vertically on a rigid test platform such that the siding/furring strip was not over the support and the non-flush end was at the top. (The support platform was adjusted to accommodate the various assembly depths.) The 12" x 16" backing material portion of the test sample was clamped to a rigid member located opposite the siding/furring strip. A dial indicator was positioned over the top of the siding/furring strip with its base connected to the backing material. The dial indicator was oriented parallel with the long-axis of the siding/furring strip. A hole was drilled thru the siding/furring strip 2" from the bottom end. A threaded rod was set thru the hole.

The siding/furring strip was restrained from out-of-plane movement by the fasteners into the backing material. No additional restraints were provided.

11. TEST PROCEDURE

A. Fastener Withdrawal Test

The test machine was set to a load rate of .100" inches per minute. The data acquisition system recorded the load and displacement throughout the test. The test was stopped when the load was no longer increasing due to the fastener slipping. The maximum load and observations were recorded.

B. Assembly Shear Test

The test machine was set to a load rate of .200" inches per minute. This load rate was selected due to the excessive deflection before failure. The data acquisition system recorded the load and displacement throughout the test. The test was stopped when the load was no longer increasing due to the fastener withdrawal or the fasteners broke. The maximum load and failure mode(s) were recorded by the technician.

C. Long-Term Creep Test

An initial dial indicator reading was recorded. Weights were added to the threaded rod equivalent to 66% of the average load at .015" deflection when the identical assembly was tested in accordance with Section 11B of this report. Immediately after application of the weights another dial indicator reading was recorded. The dial indicator was read and recorded at a minimum of 1 day, 1 week, 2 weeks, and 4 weeks.

12. TEST RESULTS

See attached data pages and charts for details.

Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 1/13/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.1-(a1)

Project No.: 2009-1407
Temp.: 70.0 °F
Humidity: 21% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: Steel Hat Channel (33 mil)	**Fastener:** (4) 7d box nails (.099" x 2-1/4") bright, smooth
Foam: 1" EPS	**Furring Predrill:** 1/8" dia.
Sheathing: 7/16" OSB	**Remaining Material Predrill:** N/A
Stud: N/A	

Test Results

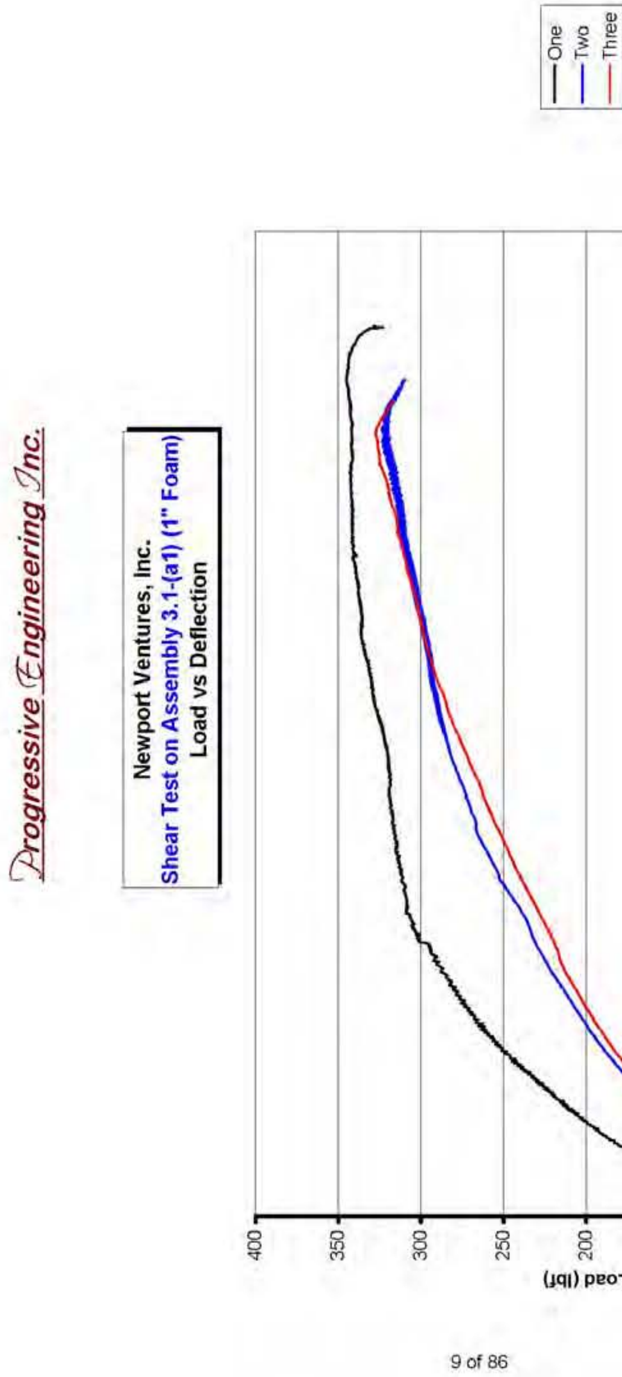
Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	345	1.356"	78	186	243	283	IV
2	324	1.258"	64	136	182	215	IV
3	328	1.272"	44	132	177	208	IV
Average	332	1.295"	62	151	201	235	
COV	*3%*	*4%*	*28%*	*20%*	*18%*	*18%*	

*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.

Specimen Construction


Typical Test Set-up


Typical Failure



Progressive Engineering Inc.
Newport Ventures, Inc.
Shear Test on Assembly 3.1-(a1) (1" Foam)
Load vs Deflection
Load (lbf)
0
50
100
150
200
250
300
350
400
Deflection (inches)
0.000
0.200
0.400
0.600
0.800
1.000
1.200
1.400
1.600
One
Two
Three
9 of 86

Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 1/13/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.1-(a2)

Project No.: 2009-1407
Temp.: 70.0 °F
Humidity: 21% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: Steel Hat Channel (33 mil)	**Fastener:** (4) .135" (10g) x 6" Foundry nails, bright, smooth
Foam: 4" EPS	**Furring Predrill:** 3/16" dia.
Sheathing: 3/4" OSB	**Remaining Material Predrill:** N/A
Stud: N/A	

Test Results

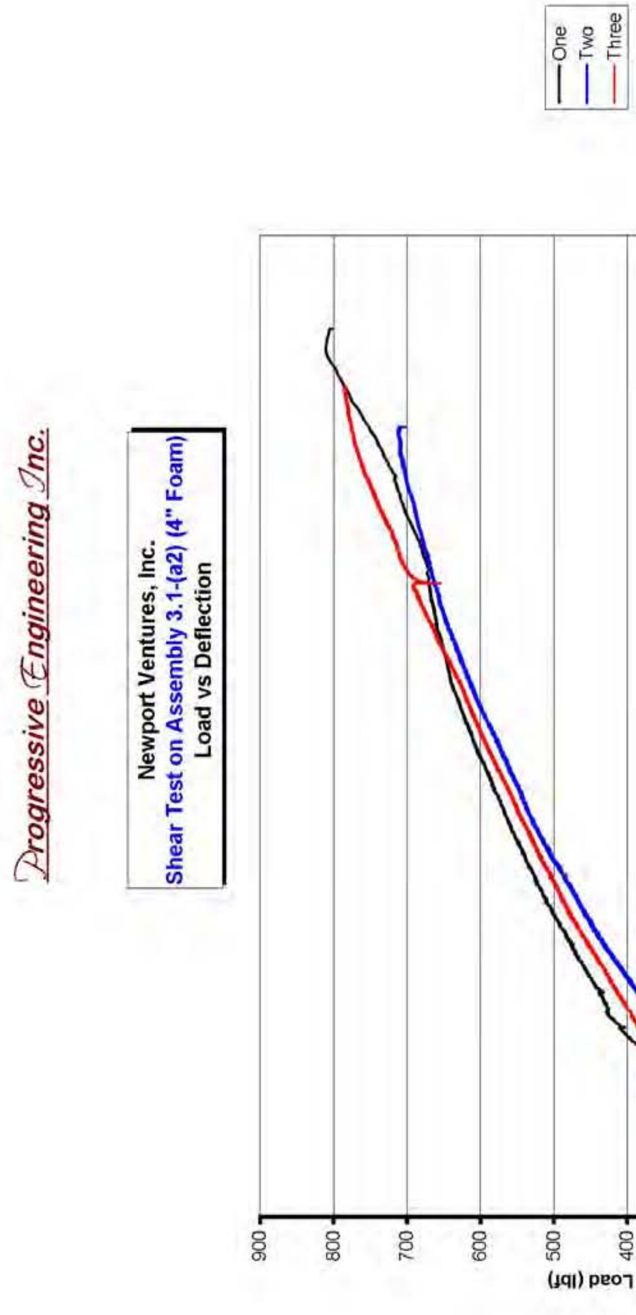
Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	811	3.545"	58	135	220	281	III_s
2	714	3.203"	70	135	201	249	III_s
3	788	3.369"	108	179	220	273	III_s
Average	771	3.372"	79	150	214	268	
COV	*7%*	*5%*	*33%*	*17%*	*5%*	*6%*	

*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.

Specimen Construction

Typical Test Set-up

Typical Failure


Progressive Engineering Inc.
Newport Ventures, Inc.
Shear Test on Assembly 3.1-(a2) (4" Foam)
Load vs Deflection
One
Two
Three
Load (lbf)
Deflection (inches)
0
100
200
300
400
500
600
700
800
900
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
4.000

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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 1/13/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.1-(a3)

Project No.: 2009-1407
Temp.: 70.0 °F
Humidity: 21% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: Steel Hat Channel (33 mil)	**Fastener:** (4) 7d box nails (.099" x 2-1/4") bright, smooth
Foam: N/A	**Furring Predrill:** 1/8" dia.
Sheathing: 7/16" OSB	**Remaining Material Predrill:** N/A
Stud: N/A	

Test Results

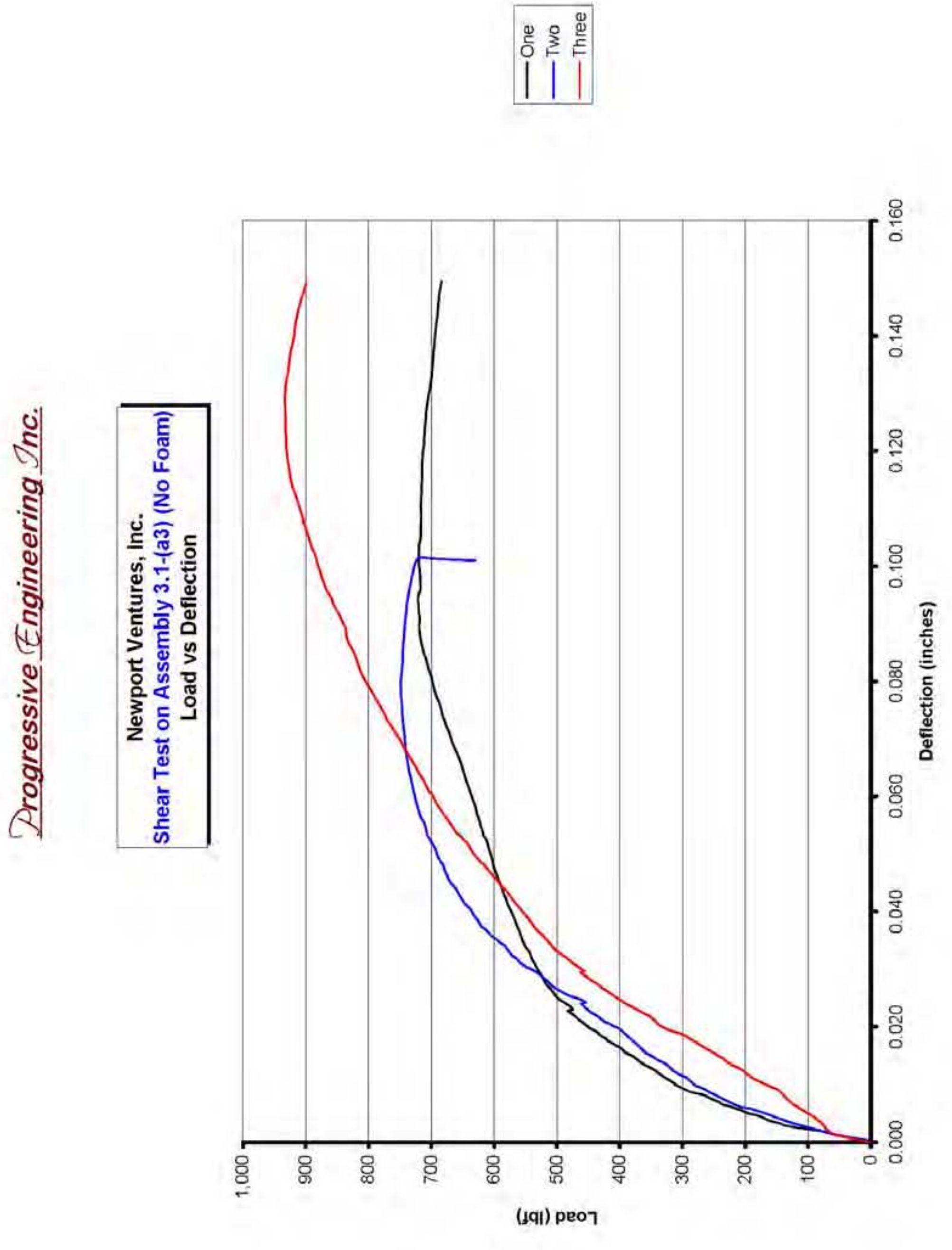
Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	722	.094"	380	722	722	722	III_s
2	749	.080"	350	749	749	749	III_s
3	934	.129"	241	932	934	934	III_s
Average	802	.101"	324	801	802	802	
COV	*14%*	*25%*	*23%*	*14%*	*14%*	*14%*	

*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.

Specimen Construction


Typical Test Set-up


Typical Failure


Progressive Engineering Inc.
Newport Ventures, Inc.
Shear Test on Assembly 3.1-(a3) (No Foam)
Load vs Deflection
Load (lbf)
Deflection (inches)
1,000
900
800
700
600
500
400
300
200
100
0
0.000
0.020
0.040
0.060
0.080
0.100
0.120
0.140
0.160
One
Two
Three

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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 1/26/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.1-(b1)

Project No.: 2009-1407
Temp.: 66.0 °F
Humidity: 24% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: Steel Hat Channel (33 mil)	**Fastener:** (2) #8 x 2-3/8" bugle-head screws, Item 30SRG
Foam: 1" EPS	**Furring Predrill:** 3/16" dia.
Sheathing: N/A	**Remaining Material Predrill:** 1/16" dia.
Stud: Steel (33 mil)	

Test Results

Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	494	.801"	35	57	100	185	II
2	536	.558"	40	105	204	329	II
3	426	.600"	50	80	137	238	II
Average	485	.653"	42	81	147	251	
COV	*11%*	*20%*	*18%*	*30%*	*36%*	*29%*	

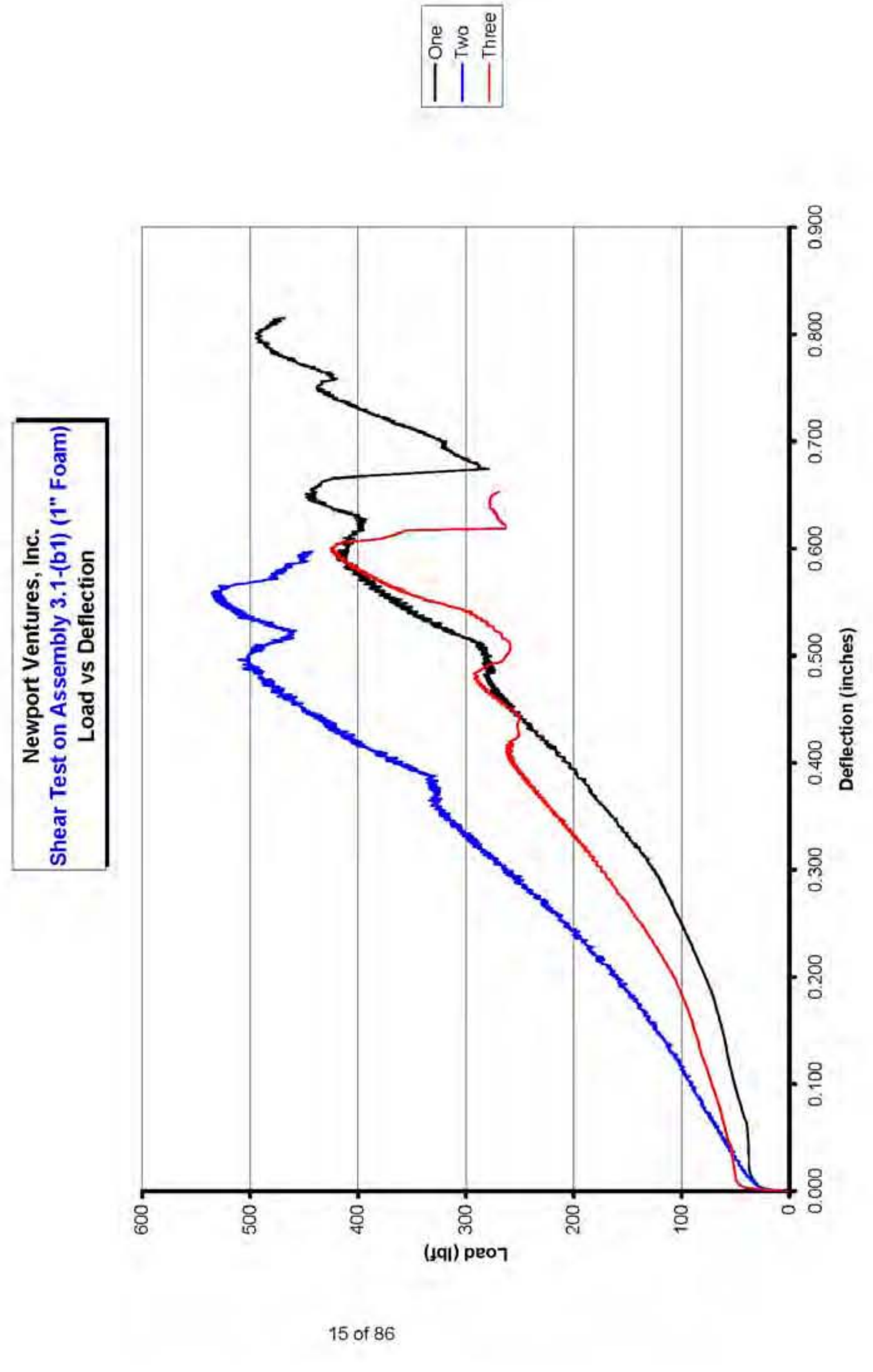
*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.


Specimen Construction


Typical Test Set-up


Typical Failure

Progressive Engineering Inc.



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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 1/25/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.1-(b2)

Project No.: 2009-1407
Temp.: 70.0 °F
Humidity: 23% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: Steel Hat Channel (33 mil)	**Fastener:** (2) #10 x 5" bugle-head screws, Item B10500SDRG
Foam: 4" EPS	**Furring Predrill:** 3/16" dia.
Sheathing: N/A	**Remaining Material Predrill:** 3/32" dia.
Stud: Steel (54 mil)	

Test Results

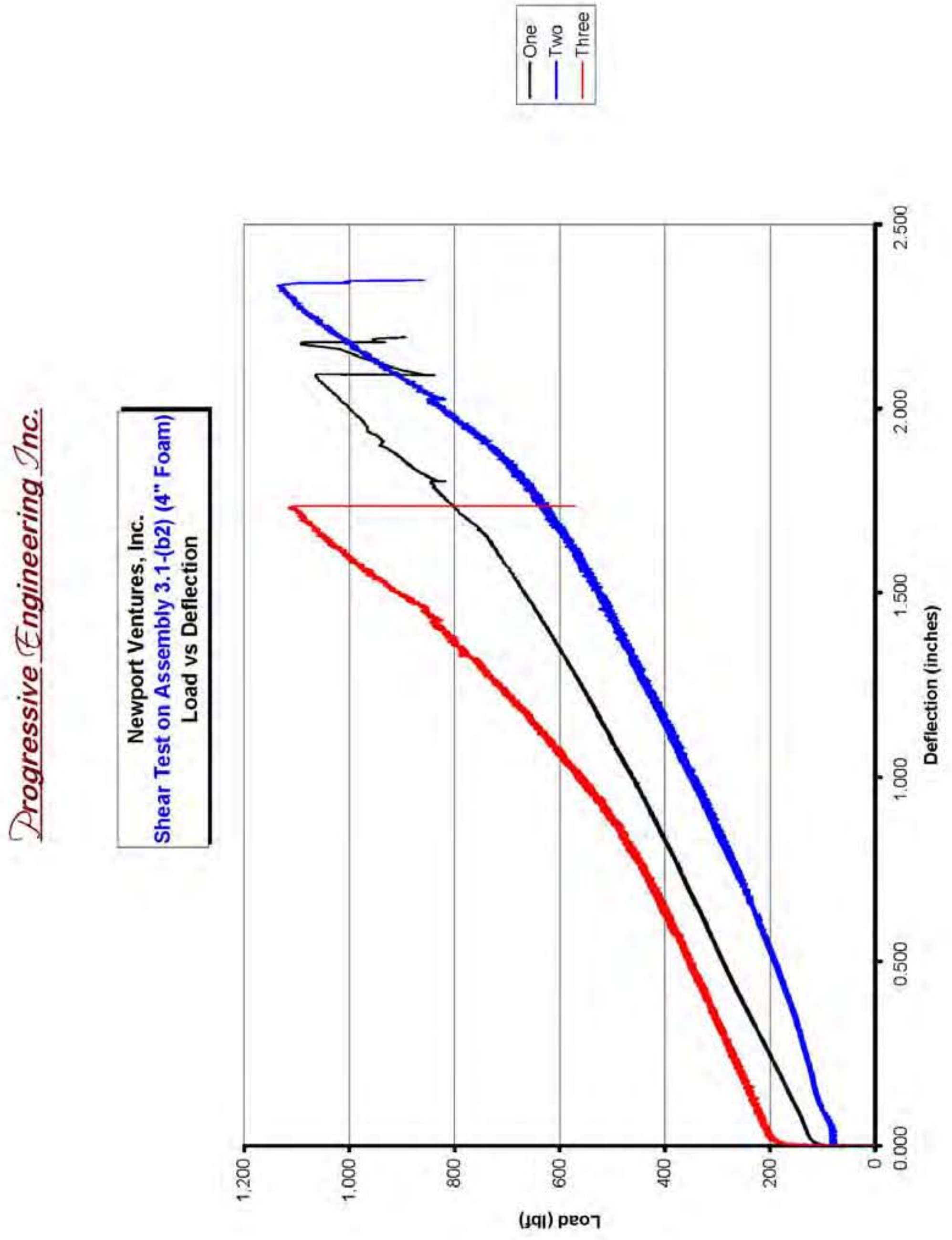
Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at:				*Connection Yield Mode
			.015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	
1	1092	2.175"	123	158	201	245	II
2	1136	2.333"	84	109	133	161	II
3	1116	1.730"	201	240	278	316	II
Average	1115	2.079"	136	169	204	241	
COV	*2%*	*15%*	*44%*	*39%*	*36%*	*32%*	

*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.

Specimen Construction

Typical Test Set-up

Typical Failure


Progressive Engineering Inc.
Newport Ventures, Inc.
Shear Test on Assembly 3.1-(b2) (4" Foam)
Load vs Deflection
Load (lbf)
Deflection (inches)
0
200
400
600
800
1,000
1,200
0.000
0.500
1.000
1.500
2.000
2.500
One
Two
Three

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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 1/26/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.1-(b3)

Project No.: 2009-1407
Temp.: 66.0 °F
Humidity: 24% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: Steel Hat Channel (33 mil)	**Fastener:** (2) #8 x 2-3/8" bugle-head screws, Item 30SRG
Foam: N/A	**Furring Predrill:** 1/16" dia.
Sheathing: N/A	**Remaining Material Predrill:** 1/16" dia.
Stud: Steel (33 mil)	

Test Results

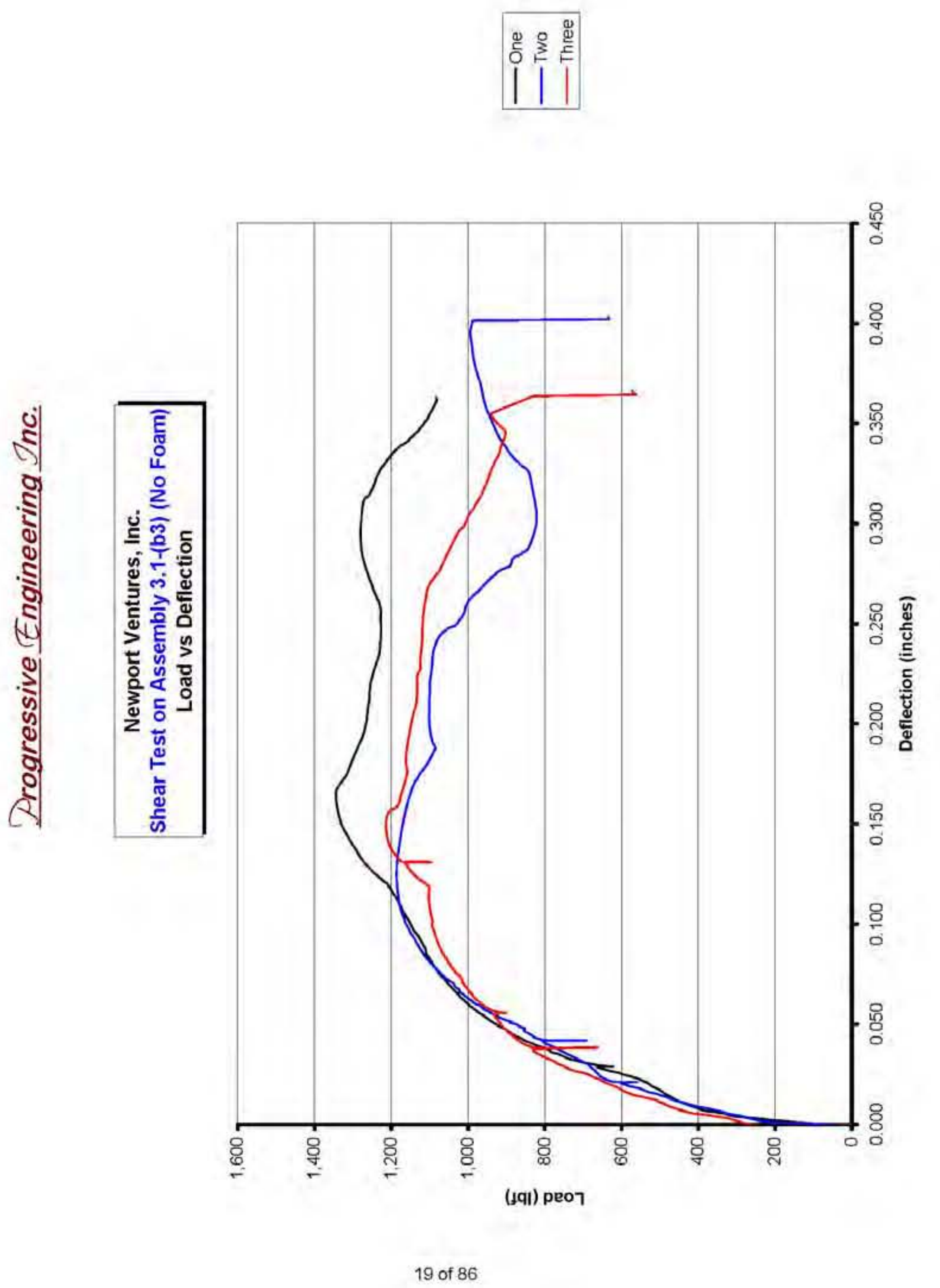
Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	1344	.163"	483	1239	1344	1344	I_M
2	1186	.126"	502	1186	1186	1186	I_M
3	1214	.148"	575	1142	1214	1214	I_M
Average	1248	.146"	520	1189	1248	1248	
COV	*7%*	*13%*	*9%*	*4%*	*7%*	*7%*	

*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.

Specimen Construction

Typical Test Set-up

Typical Failure


Progressive Engineering Inc.
Newport Ventures, Inc.
Shear Test on Assembly 3.1-(b3) (No Foam)
Load vs Deflection
Load (lbf)
Deflection (inches)
One
Two
Three
0
200
400
600
800
1,000
1,200
1,400
1,600
0.000
0.050
0.100
0.150
0.200
0.250
0.300
0.350
0.400
0.450
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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 1/22/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.1-(b4)

Project No.: 2009-1407
Temp.: 66.0 °F
Humidity: 24% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: Steel Hat Channel (33 mil)	**Fastener:** (2) #10 x 5" bugle-head screws, Item B10500SDRG
Foam: 2" EPS	**Furring Predrill:** 3/16" dia.
Sheathing: N/A	**Remaining Material Predrill:** 3/32" dia.
Stud: Steel (33 mil)	

Test Results

Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	414	.964"	60	86	115	156	II
2	357	.780"	46	73	107	157	II
3	396	.881"	76	102	142	187	II
Average	389	.875"	61	87	121	167	
COV	*7%*	*11%*	*25%*	*17%*	*15%*	*11%*	

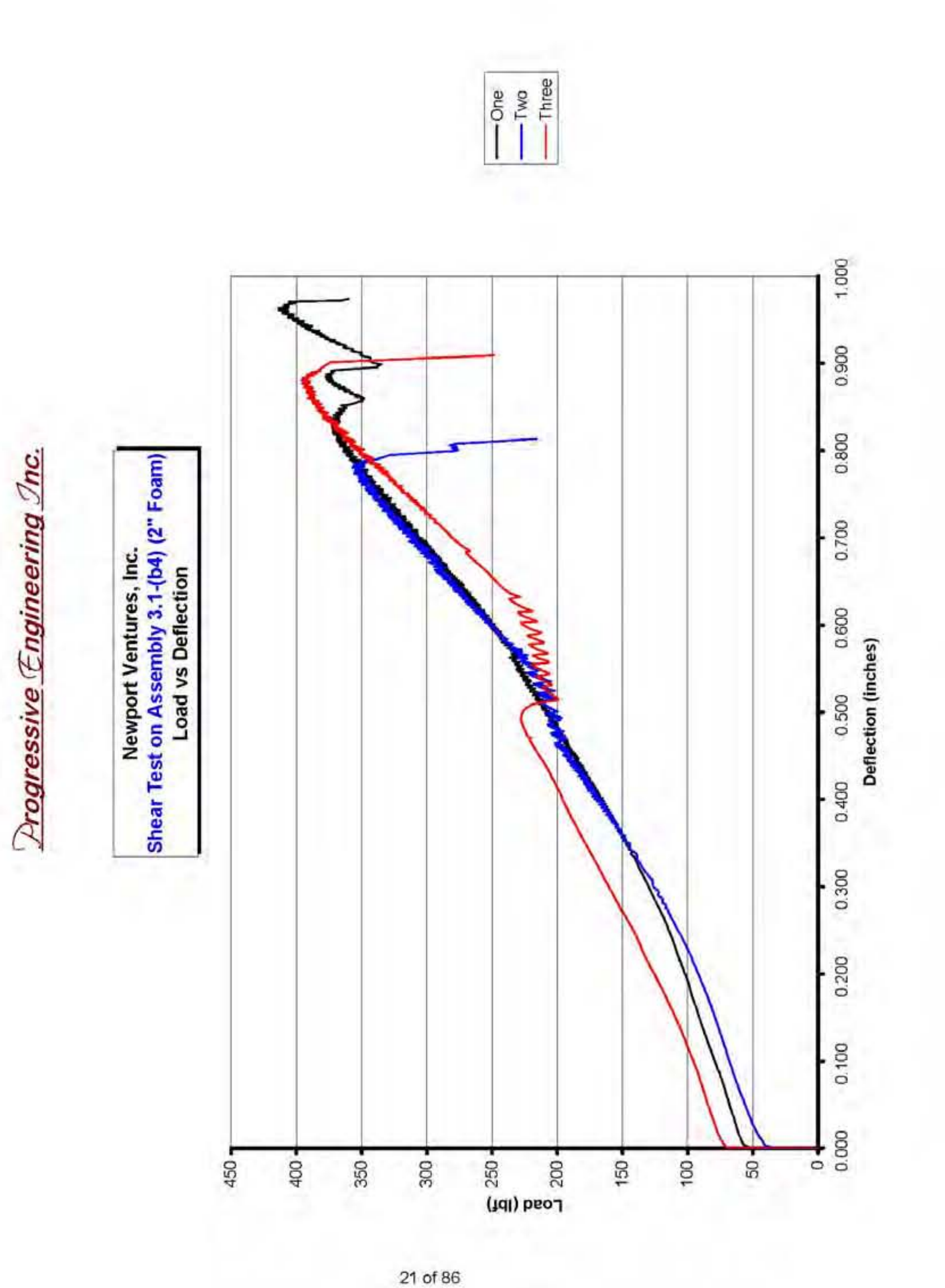
*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.

Specimen Construction

Similar to other set-ups. No picture available.

Typical Test Set-up

Typical Failure


Progressive Engineering Inc.
Newport Ventures, Inc.
Shear Test on Assembly 3.1-(b4) (2" Foam)
Load vs Deflection
Load (lbf)
Deflection (inches)
One
Two
Three
21 of 86

Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 1/26/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.1-(b5)

Project No.: 2009-1407
Temp.: 66.0 °F
Humidity: 24% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: Steel Hat Channel (33 mil)	**Fastener:** (2) #10 x 5" bugle-head screws, Item B10500SDRG
Foam: 2" EPS	**Furring Predrill:** 3/16" dia.
Sheathing: N/A	**Remaining Material Predrill:** 3/32" dia.
Stud: Steel (54 mil)	

Test Results

Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	2012	1.686"	120	182	235	295	I_M
2	1884	1.613"	141	196	258	331	I_M
3	1889	1.557"	152	198	255	317	I_M
Average	1928	1.619"	138	192	249	314	
COV	*4%*	*4%*	*12%*	*5%*	*5%*	*6%*	

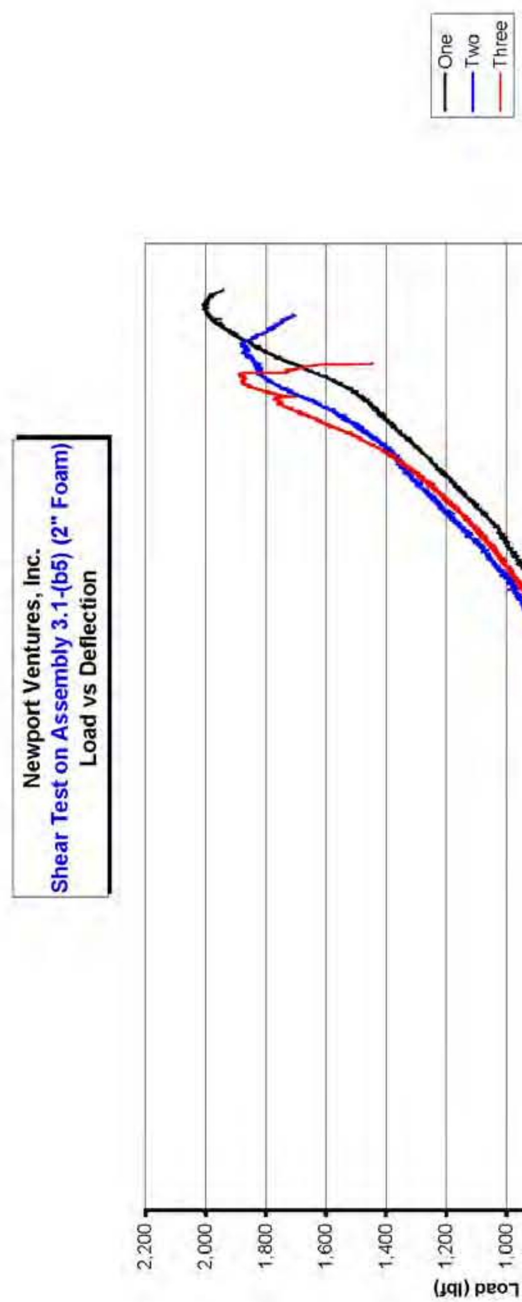
*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.

Specimen Construction

Typical Test Set-up

Typical Failure

Progressive Engineering Inc.



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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 1/19/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.2-(a1-1)

Project No.: 2009-1407
Temp.: 70.0 °F
Humidity: 21% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: 3/4" Wood	**Fastener:** (2) #8 x 3" standard wood screws
Foam: 1" EPS	**Furring Predrill:** 1/16" dia.
Sheathing: 7/16" OSB	**Remaining Material Predrill:** 1/16" dia.
Stud: N/A	

Test Results

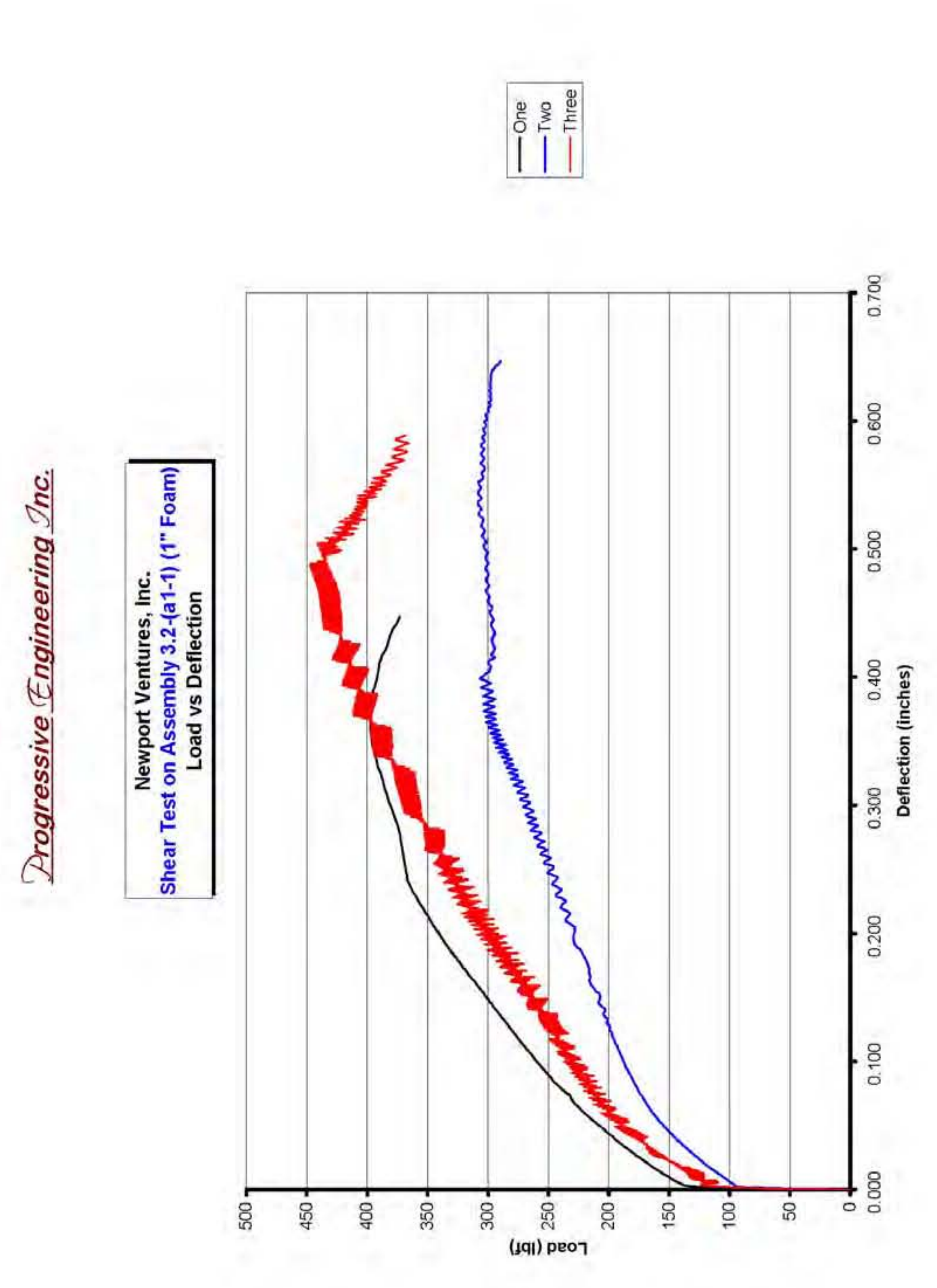
Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	398	.367"	158	280	368	398	III_M
2	308	.536"	112	200	248	299	III_M
3	447	.487"	138	251	337	395	III_M
Average	384	.463"	136	244	318	364	
COV	*18%*	*19%*	*17%*	*17%*	*20%*	*15%*	

*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.

Specimen Construction

Typical Test Set-up

Typical Failure


Progressive Engineering Inc.
Newport Ventures, Inc.
Shear Test on Assembly 3.2-(a1-1) (1" Foam)
Load vs Deflection
Load (lbf)
Deflection (inches)
One
Two
Three
0
50
100
150
200
250
300
350
400
450
500
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700

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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 1/25/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing (Long Term Loading)
Specimen Assembly No.: 3.2-(a1-2)

Project No.: 2009-1407
Temp.: 70.0 °F
Humidity: 24% R.H.
Load Rate: NA

Specimen Construction

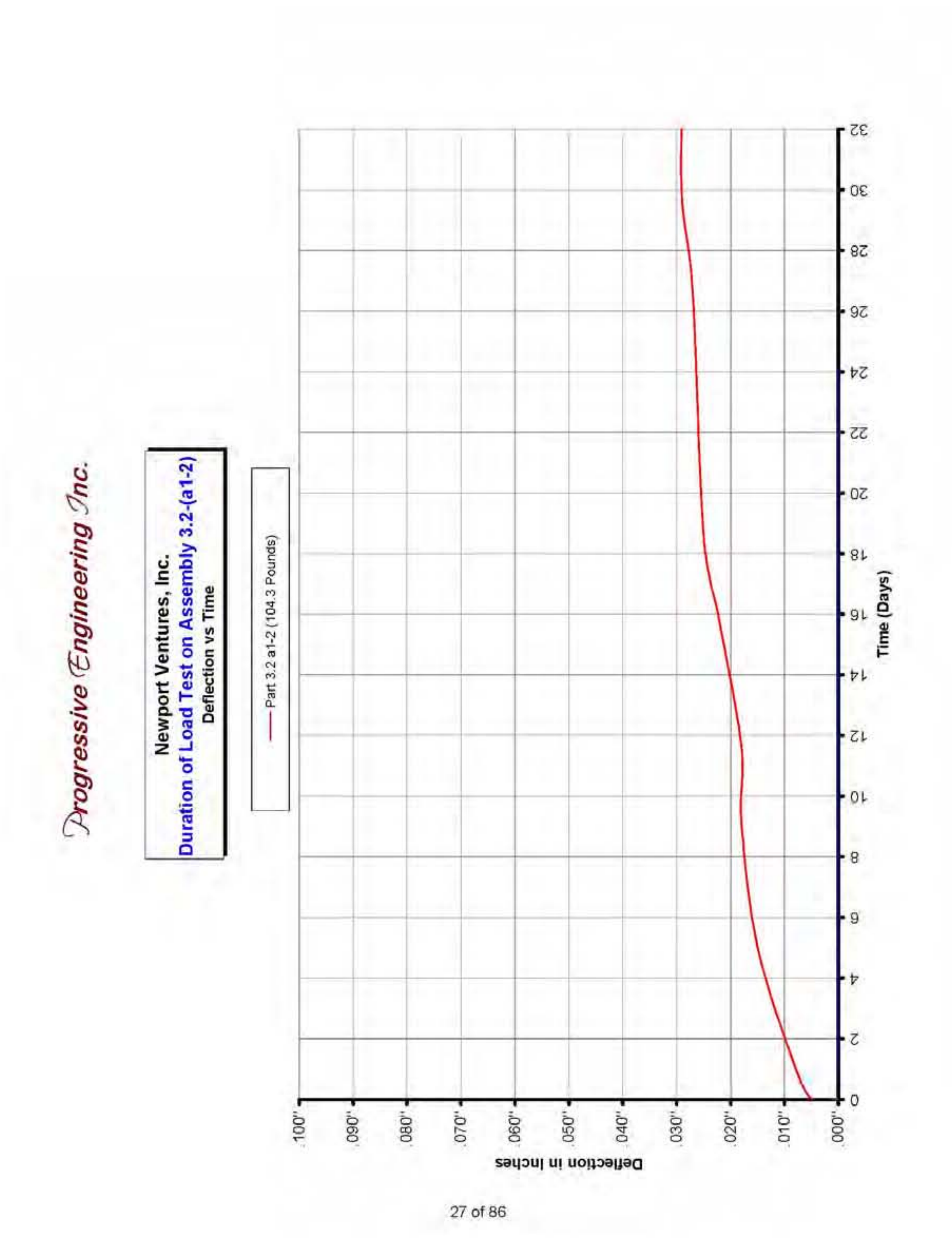
Furring: 3/4" Wood	**Fastener:** (2) #8 x 3" standard wood screws
Foam: 1" EPS	**Furring Predrill:** 1/16" dia.
Sheathing: 7/16" OSB	**Remaining Material Predrill:** 1/16" dia.
Stud: N/A	

Test Results

Sample	Applied Load (lbs)	Deflection at 1 Day	Deflection at 1 Week	Deflection at 1 Month
1	104.3	.008"	.018"	.029"

Specimen Construction

Typical Test Set-up


Progressive Engineering Inc.
Newport Ventures, Inc.
Duration of Load Test on Assembly 3.2-(a1-2)
Deflection vs Time
Part 3.2 a1-2 (104.3 Pounds)
Deflection in Inches
.100"
.090"
.080"
.070"
.060"
.050"
.040"
.030"
.020"
.010"
.000"
Time (Days)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 12/28/2009
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.2-(a1-3)

Project No.: 2009-1407
Temp.: 70.0 °F
Humidity: 21% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: 3/8" Wood	**Fastener:** (2) 7d box nails (.099" x 2-1/4") bright, smooth
Foam: 1" EPS	**Furring Predrill:** N/A
Sheathing: 7/16" OSB	**Remaining Material Predrill:** N/A
Stud: N/A	

Test Results

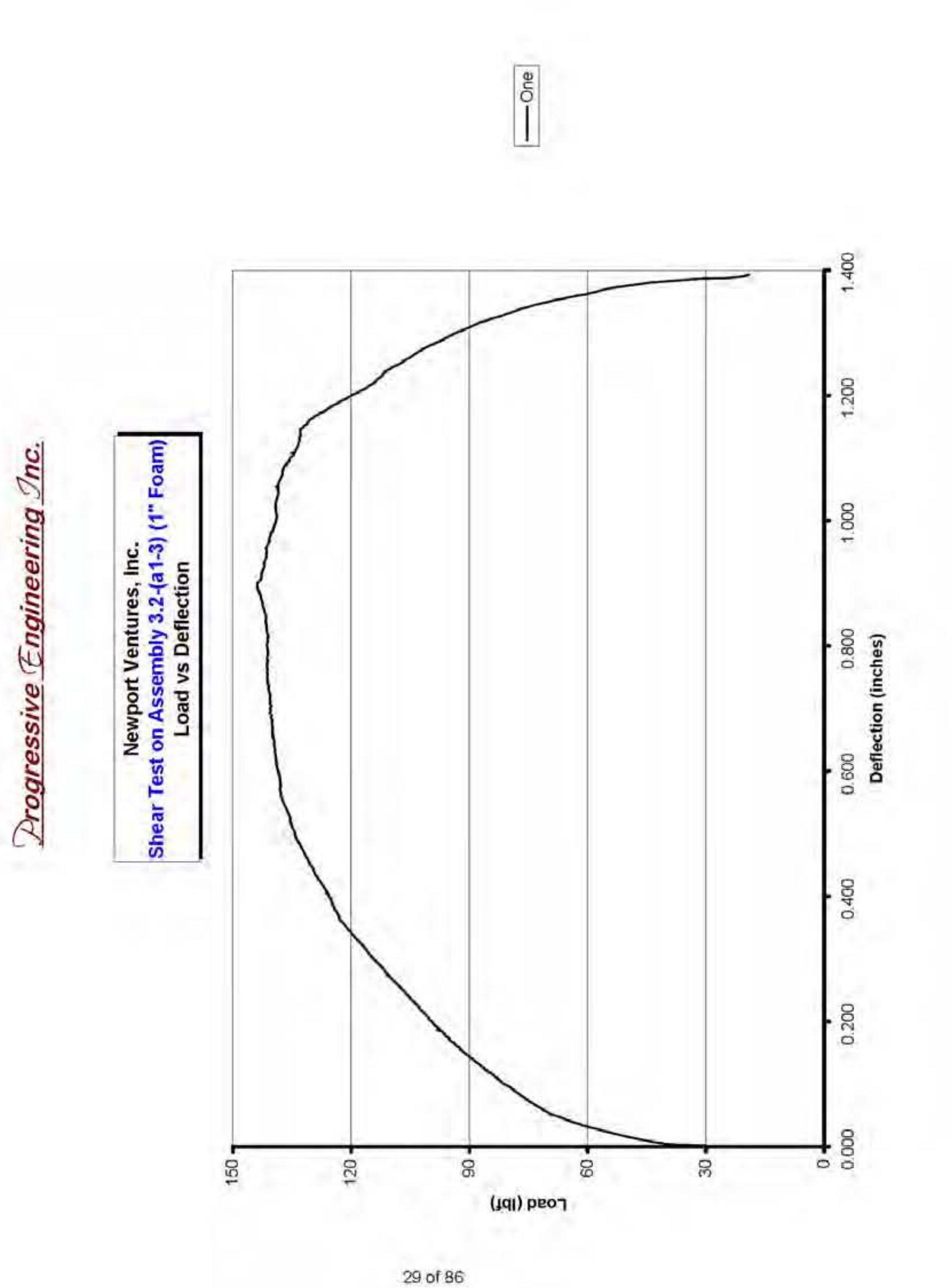
Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	144	.898"	49	86	107	124	III_M

*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.

Specimen Construction

Typical Test Set-up

Typical Failure


Progressive Engineering Inc.
Newport Ventures, Inc.
Shear Test on Assembly 3.2-(a1-3) (1" Foam)
Load vs Deflection
Load (lbf)
150
120
90
60
30
0
0.000
0.200
0.400
0.600
0.800
1.000
1.200
1.400
Deflection (inches)
One
29 of 86

Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 1/21/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.2-(a1-4)

Project No.: 2009-1407
Temp.: 70.0 °F
Humidity: 23% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: 3/4" Wood	**Fastener:** (2) #8 x 1-1/2" standard wood screws
Foam: N/A	**Furring Predrill:** 3/32" dia.
Sheathing: 7/16" OSB	**Remaining Material Predrill:** 3/32" dia.
Stud: N/A	

Test Results

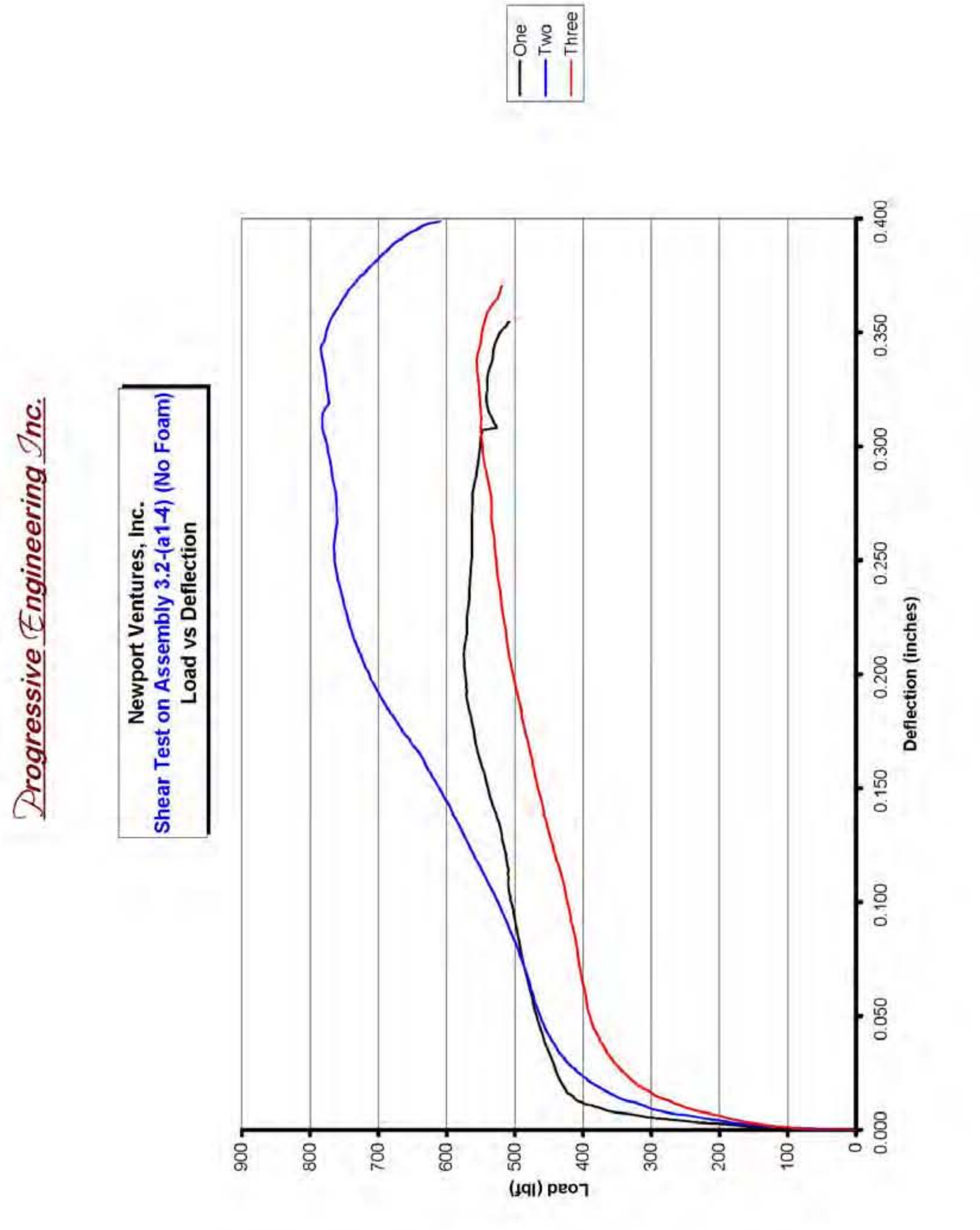
Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	575	.209"	415	516	575	575	III_M
2	784	.343"	351	566	764	784	III_M
3	556	.336"	292	444	527	556	III_M
Average	638	.296"	353	509	622	638	
COV	*20%*	*25%*	*17%*	*12%*	*20%*	*20%*	

*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.

Specimen Construction

Typical Test Set-up

Typical Failure



Progressive Engineering Inc.
Newport Ventures, Inc.
Shear Test on Assembly 3.2-(a1-4) (No Foam)
Load vs Deflection
Load (lbf)
Deflection (inches)
One
Two
Three
0
100
200
300
400
500
600
700
800
900
0.000
0.050
0.100
0.150
0.200
0.250
0.300
0.350
0.400

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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 1/19/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.2-(a2-1)

Project No.: 2009-1407
Temp.: 70.0 °F
Humidity: 21% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: 3/4" Wood	**Fastener:** (2) 1/4" x 6" lag screws
Foam: 4" EPS	**Furring Predrill:** 1/8" dia.
Sheathing: 3/4" OSB	**Remaining Material Predrill:** 15/64" dia.
Stud: N/A	

Test Results

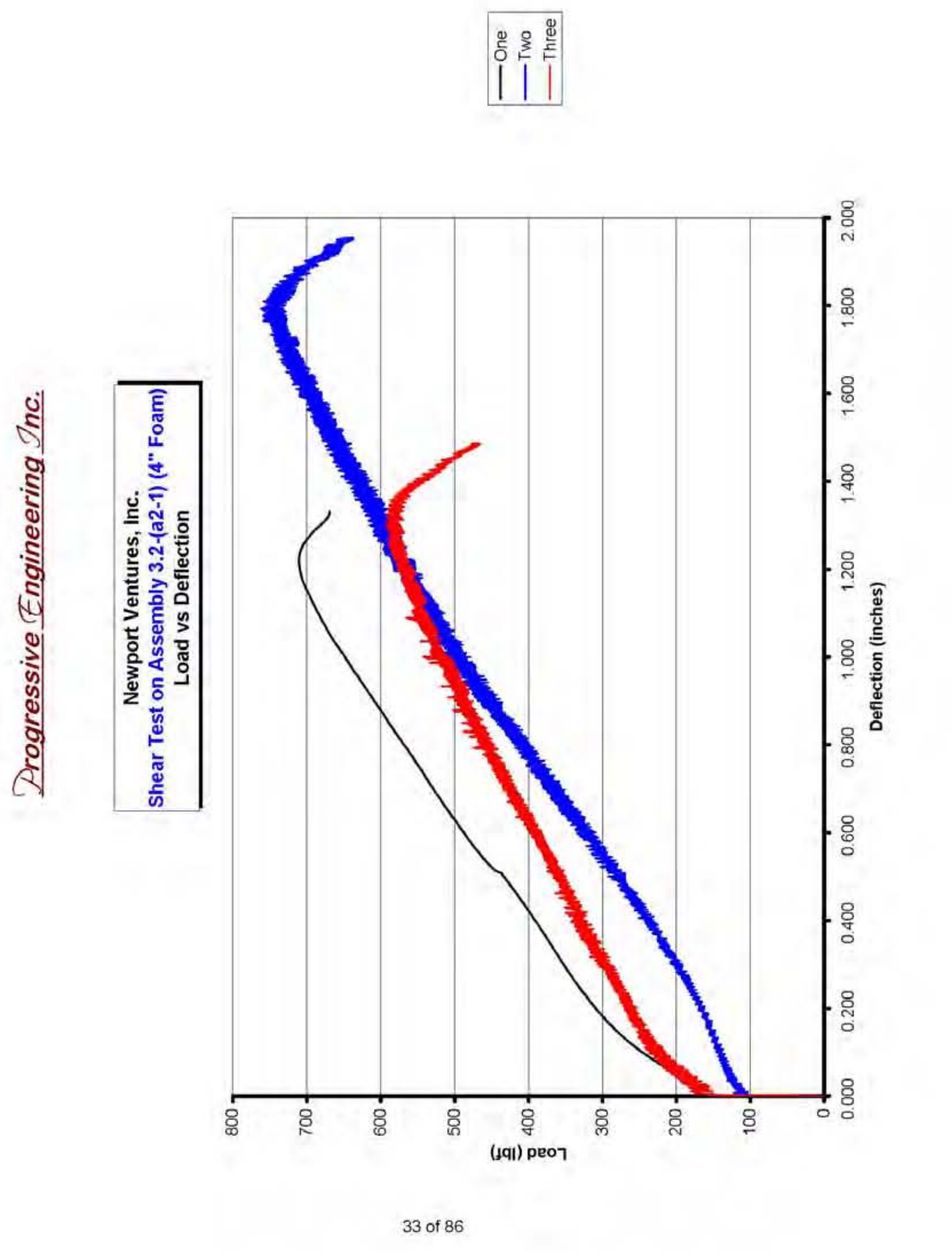
Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	711	1.212"	174	265	333	381	III_M
2	761	1.793"	115	146	183	230	III_M
3	592	1.305"	180	247	283	328	III_M
Average	688	1.437"	156	219	266	313	
COV	*13%*	*22%*	*23%*	*29%*	*29%*	*24%*	

*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.

Specimen Construction

Typical Test Set-up

Typical Failure



Progressive Engineering Inc.
Newport Ventures, Inc.
Shear Test on Assembly 3.2-(a2-1) (4" Foam)
Load vs Deflection
Load (lbf)
0
100
200
300
400
500
600
700
800
Deflection (inches)
0.000
0.200
0.400
0.600
0.800
1.000
1.200
1.400
1.600
1.800
2.000
One
Two
Three
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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 1/25/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing (Long Term Loading)
Specimen Assembly No.: 3.2-(a2-2)

Project No.: 2009-1407
Temp.: 70.0 °F
Humidity: 24% R.H.
Load Rate: .2" per minute

Specimen Construction

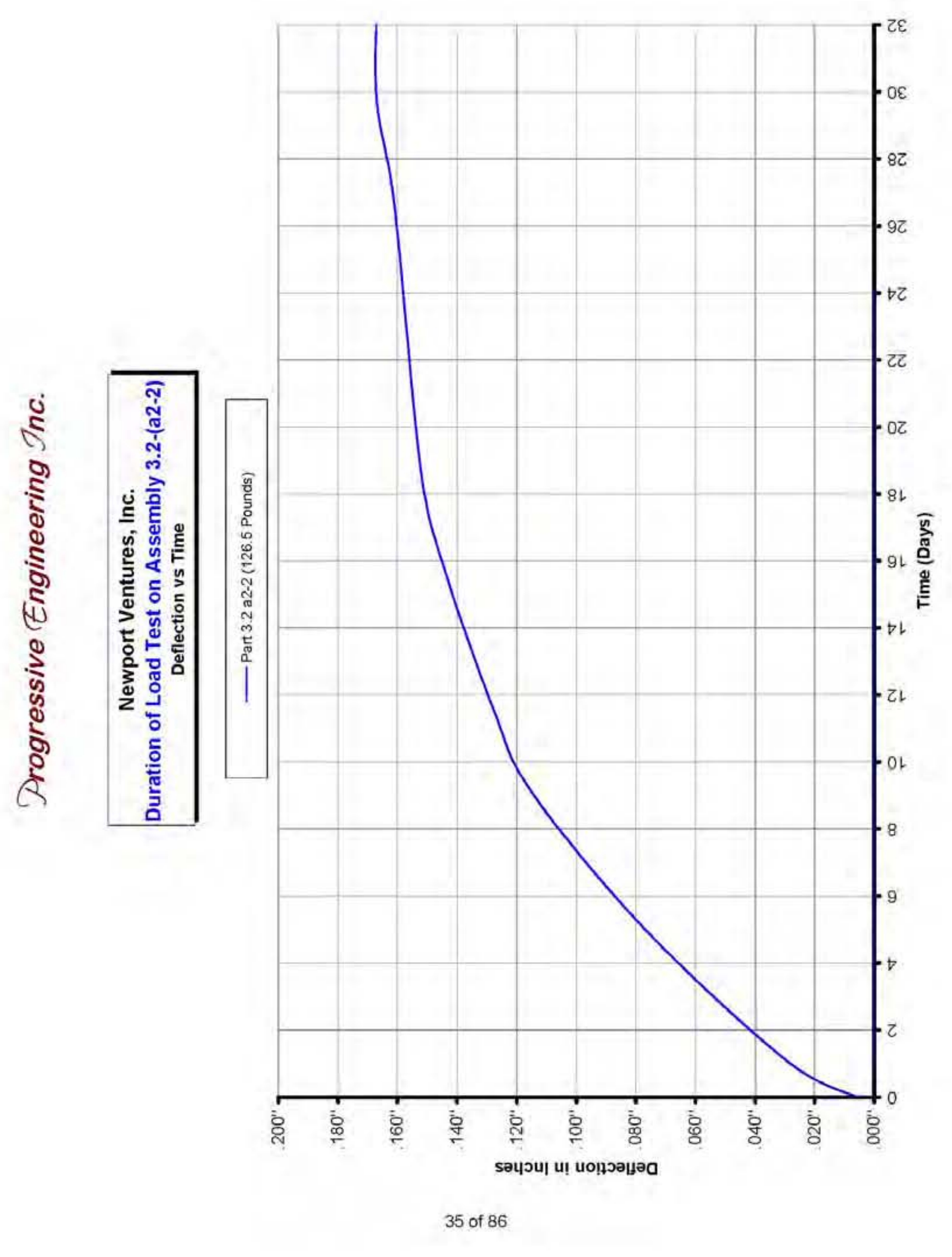
Furring: 3/4" Wood	**Fastener:** (2) 1/4" x 6" lag screws
Foam: 4" EPS	**Furring Predrill:** 1/8" dia.
Sheathing: 3/4" OSB	**Remaining Material Predrill:** 15/64" dia.
Stud: N/A	

Test Results

Sample	Applied Load (lbs)	Deflection at 1 Day	Deflection at 1 Week	Deflection at 1 Month
1	126.5	.029"	.115"	.167"

Specimen Construction

Typical Test Set-up



Progressive Engineering Inc.
Newport Ventures, Inc.
Duration of Load Test on Assembly 3.2-(a2-2)
Deflection vs Time
Part 3.2 a2-2 (126.5 Pounds)
Deflection in Inches
.000"
.020"
.040"
.060"
.080"
.100"
.120"
.140"
.160"
.180"
.200"
Time (Days)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 12/29/2009
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.2-(a2-3)

Project No.: 2009-1407
Temp.: 70.0 °F
Humidity: 21% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: 3/4" Wood	**Fastener:** (2) .135" (10g) x 6" Foundry nails
Foam: 4" EPS	**Furring Predrill:** N/A
Sheathing: 3/4" OSB	**Remaining Material Predrill:** N/A
Stud: N/A	

Test Results

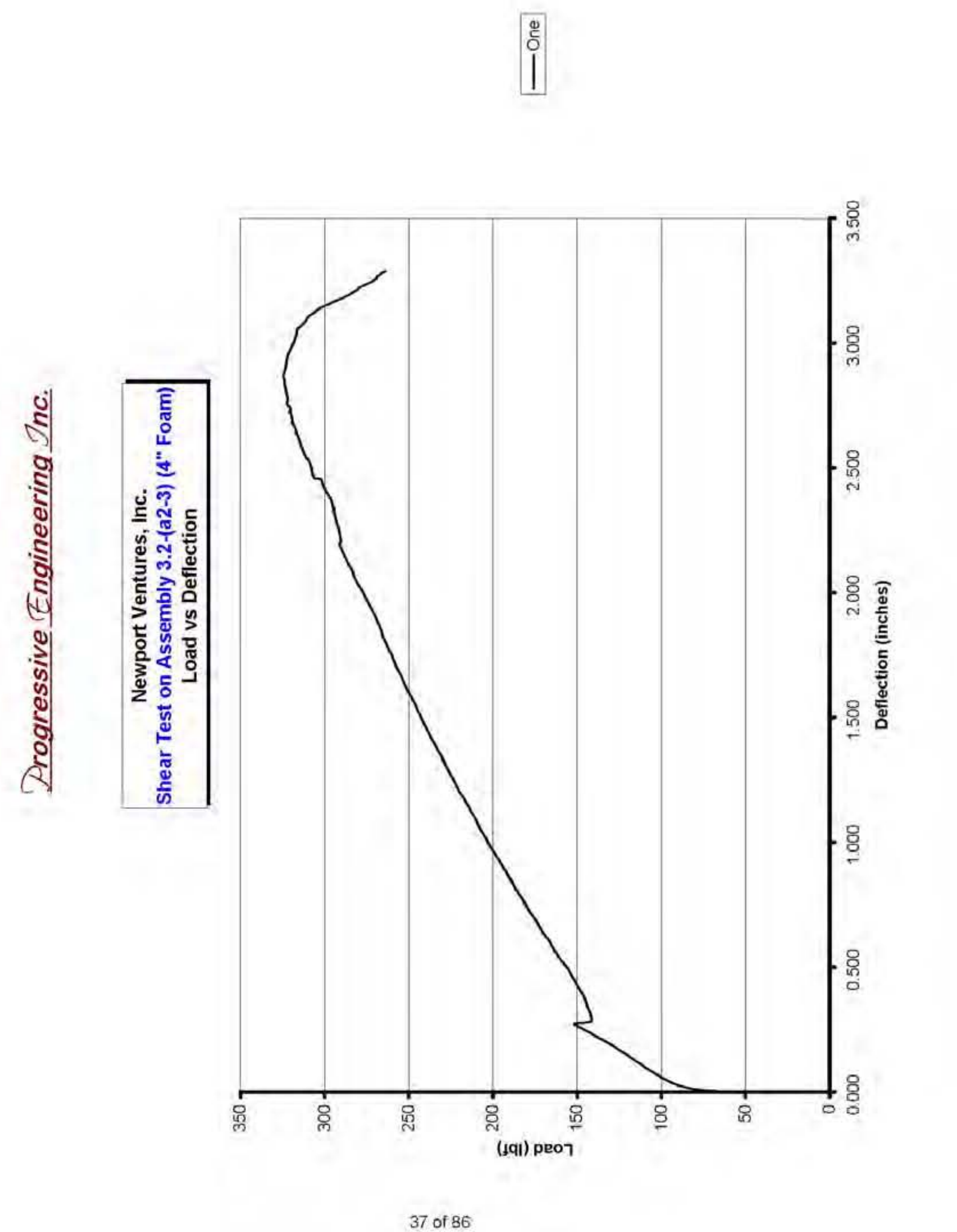
Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	325	2.863"	83	115	146	145	IV

*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.

Specimen Construction

Typical Test Set-up

Typical Failure


Progressive Engineering Inc.
Newport Ventures, Inc.
Shear Test on Assembly 3.2-(a2-3) (4" Foam)
Load vs Deflection
Load (lbf)
0
50
100
150
200
250
300
350
Deflection (inches)
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
One
37 of 86

Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 1/19/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.2-(a2-4)

Project No.: 2009-1407
Temp.: 70.0 °F
Humidity: 21% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: 3/4" Wood	**Fastener:** (2) 1/4" x 2" lag screws
Foam: N/A	**Furring Predrill:** 15/64" dia.
Sheathing: 3/4" OSB	**Remaining Material Predrill:** 1/8" dia.
Stud: N/A	

Test Results

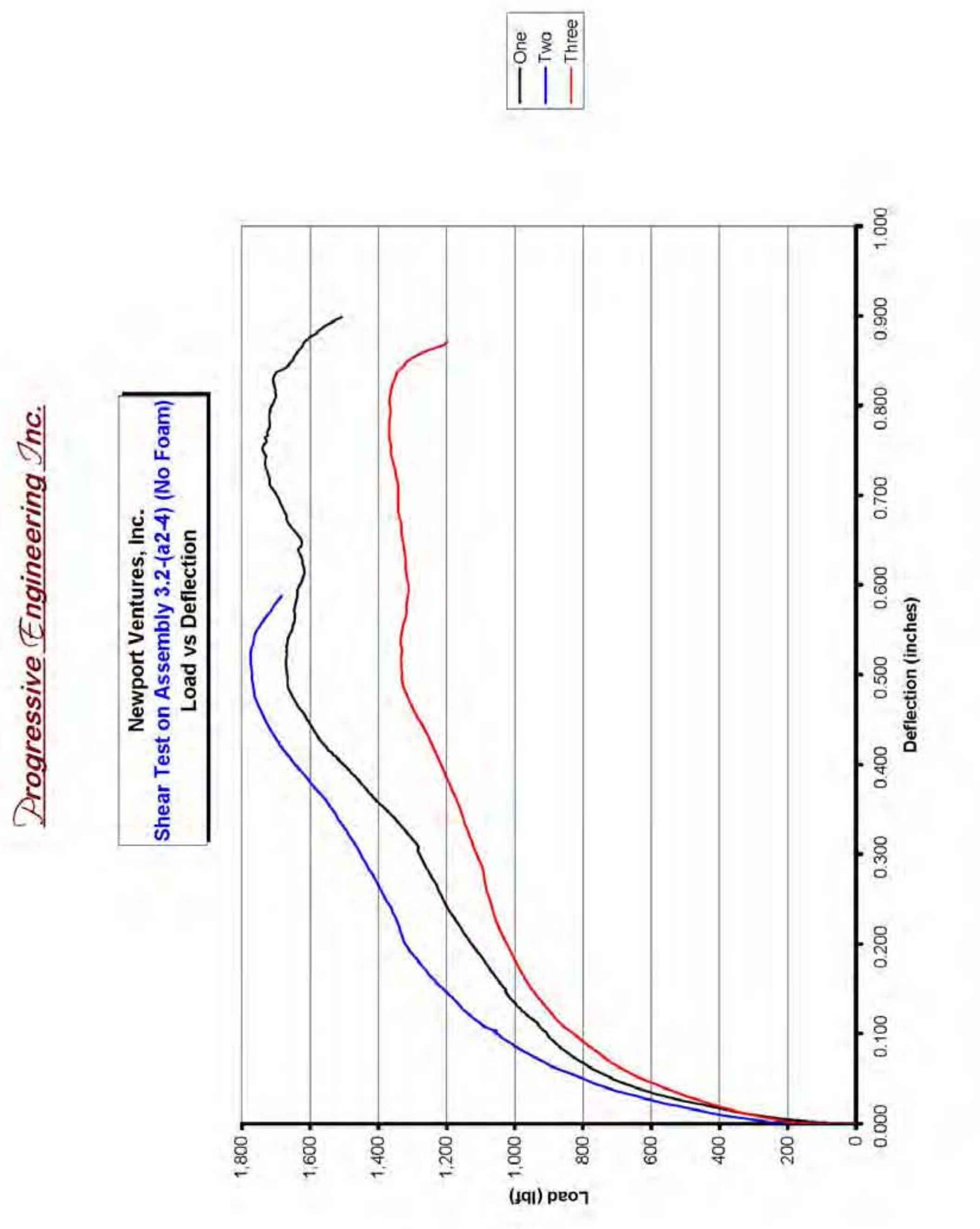
Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	1740	.752"	370	977	1210	1440	II
2	1775	.520"	463	1145	1379	1588	II
3	1369	.766"	365	871	1075	1188	II
Average	1628	.679"	399	998	1221	1405	
COV	*14%*	*20%*	*14%*	*14%*	*12%*	*14%*	

*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.

Specimen Construction

Typical Test Set-up

Typical Failure


Progressive Engineering Inc.
Newport Ventures, Inc.
Shear Test on Assembly 3.2-(a2-4) (No Foam)
Load vs Deflection
Load (lbf)
Deflection (inches)
One
Two
Three

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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 1/21/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.2-(a2-5)

Project No.: 2009-1407
Temp.: 70.0 °F
Humidity: 23% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: 3/4" Wood	**Fastener:** (2) 1/4" x 4" lag screws
Foam: 2" EPS	**Furring Predrill:** 15/64" dia.
Sheathing: 3/4" OSB	**Remaining Material Predrill:** 1/8" dia.
Stud: N/A	

Test Results

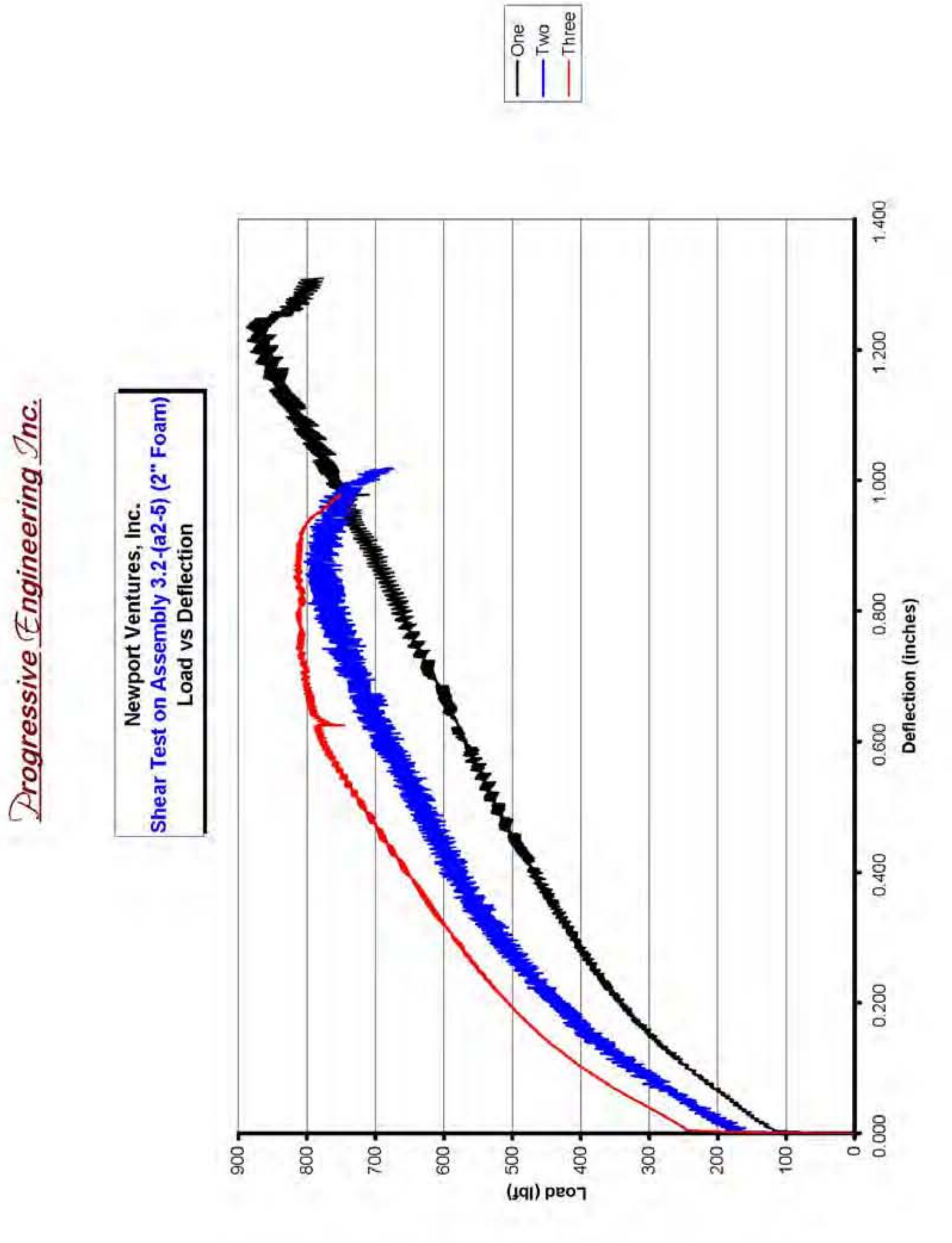
Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	888	1.235"	133	269	380	447	II
2	804	.876"	202	354	497	582	II
3	818	.852"	259	429	551	639	II
Average	837	.988"	198	351	476	556	
COV	*5%*	*22%*	*32%*	*23%*	*18%*	*18%*	

*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.

Specimen Construction

Typical Test Set-up

Typical Failure


Progressive Engineering Inc.
Newport Ventures, Inc.
Shear Test on Assembly 3.2-(a2-5) (2" Foam)
Load vs Deflection
One
Two
Three
Load (lbf)
Deflection (inches)
0
100
200
300
400
500
600
700
800
900
0.000
0.200
0.400
0.600
0.800
1.000
1.200
1.400

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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 1/25/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.2-(b1-1)

Project No.: 2009-1407
Temp.: 70.0 °F
Humidity: 21% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: 3/4" Wood	**Fastener:** (2) #8 x 2-3/8" bugle-head screws, Item 30SRG
Foam: 1" EPS	**Furring Predrill:** 3/32" dia.
Sheathing: N/A	**Remaining Material Predrill:** 1/16" dia.
Stud: Steel (33 mil)	

Test Results

Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	297	.295"	64	163	260	297	III_M
2	402	.528"	96	217	269	362	III_M
3	351	.338"	109	212	293	351	III_M
Average	350	.387"	90	197	274	337	
COV	*15%*	*32%*	*26%*	*15%*	*6%*	*10%*	

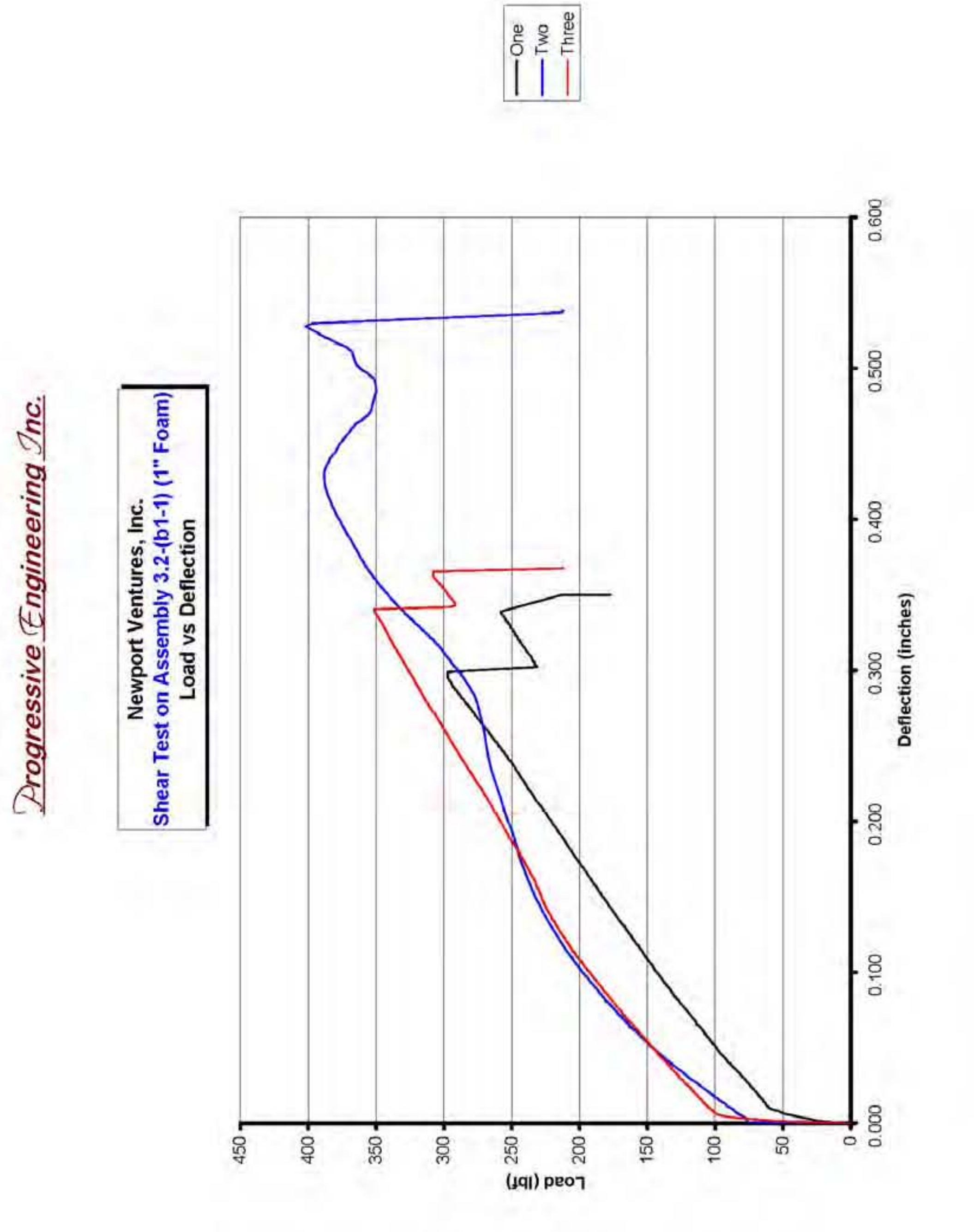
*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.

Specimen Construction

Similar to other set-ups. No picture available.

Typical Test Set-up

Typical Failure


Progressive Engineering Inc.
Newport Ventures, Inc.
Shear Test on Assembly 3.2-(b1-1) (1" Foam)
Load vs Deflection
Load (lbf)
0
50
100
150
200
250
300
350
400
450
Deflection (inches)
0.000
0.100
0.200
0.300
0.400
0.500
0.600
One
Two
Three

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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 2/25/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing (Long Term Loading)
Specimen Assembly No.: 3.2-(b1-2)

Project No.: 2009-1407
Temp.: 62.6 °F
Humidity: 34.6% R.H.
Load Rate: NA

Specimen Construction

Furring: 3/4" Wood	**Fastener:** (2) #8 x 2-3/8" bugle-head screws, Item 30SRG
Foam: 1" EPS	**Furring Predrill:** 3/32" dia.
Sheathing: NA	**Remaining Material Predrill:** 1/16" dia.
Stud: Steel (33 mil)	

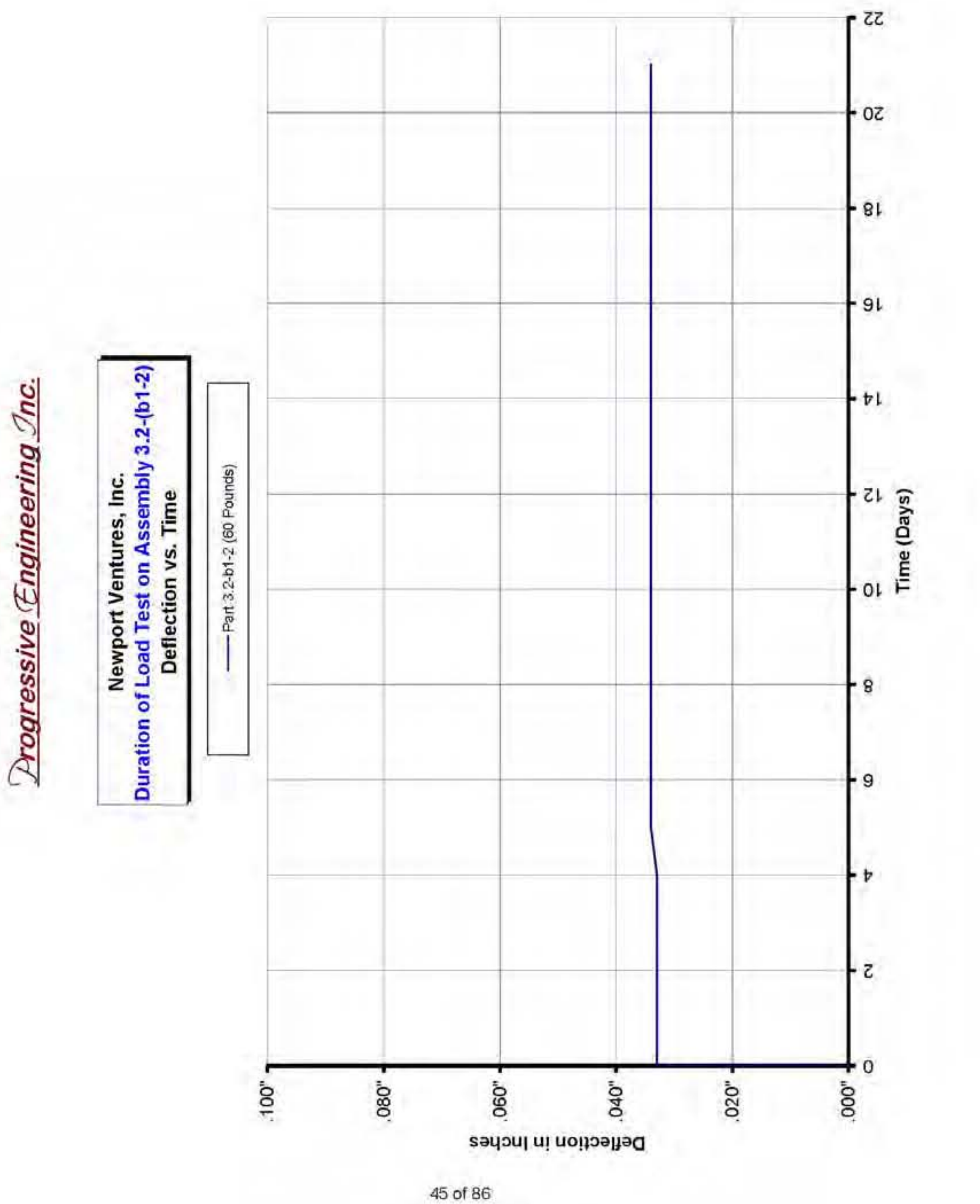
Test Results

Sample	Applied Load (lbs)	Deflection at 1 Day	Deflection at 1 Week	Deflection at 1 Month
1	60	.033"	.034"	*

* After several days without increased deflection, the testing was discontinued (see graph for details).

Typical Test Set-up

Typical Test Set-up


Progressive Engineering Inc.
Newport Ventures, Inc.
Duration of Load Test on Assembly 3.2-(b1-2)
Deflection vs. Time
Part 3.2-b1-2 (60 Pounds)
Deflection in Inches
.100"
.080"
.060"
.040"
.020"
.000"
Time (Days)
0
2
4
6
8
10
12
14
16
18
20
22
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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 1/26/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.2-(b1-3)

Project No.: 2009-1407
Temp.: 66.0 °F
Humidity: 24% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: 3/4" Wood (reduced to 3/8")	**Fastener:** (2) #8 x 2-3/8" bugle-head screws, Item 30SRG
Foam: 1" EPS	**Furring Predrill:** 3/32" dia.
Sheathing: N/A	**Remaining Material Predrill:** 1/16" dia.
Stud: Steel (33 mil)	

Test Results

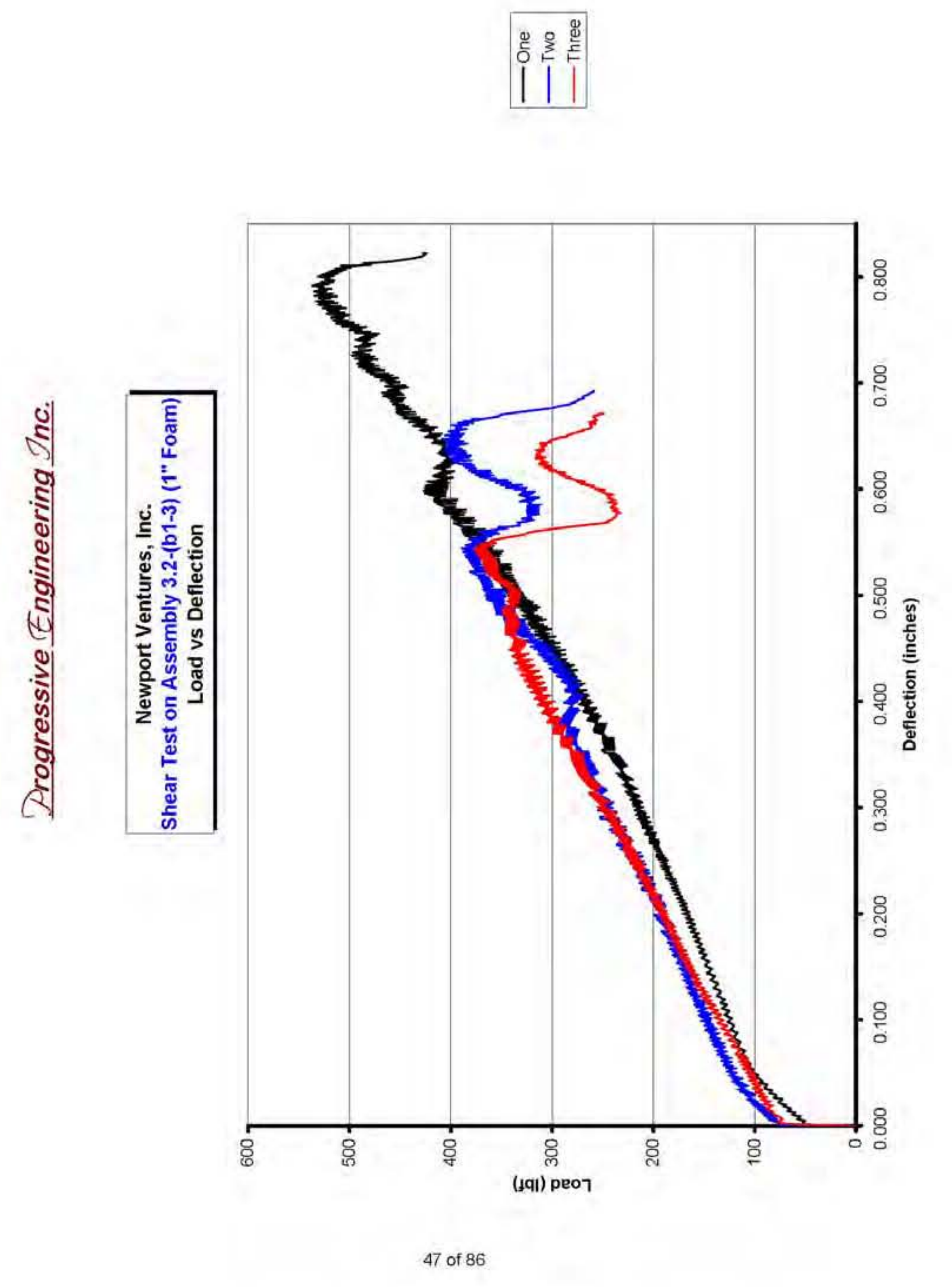
Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	537	.792"	67	135	189	258	II
2	409	.647"	95	156	221	285	II
3	376	.543"	84	151	212	299	II
Average	441	.661"	82	147	207	281	
COV	*19%*	*19%*	*17%*	*7%*	*8%*	*7%*	

*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.


Specimen Construction


Typical Test Set-up


Typical Failure



Progressive Engineering Inc.
Newport Ventures, Inc.
Shear Test on Assembly 3.2-(b1-3) (1" Foam)
Load vs Deflection
One
Two
Three
Load (lbf)
0
100
200
300
400
500
600
Deflection (inches)
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700
0.800
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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 1/26/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.2-(b1-4)

Project No.: 2009-1407
Temp.: 66.0 °F
Humidity: 24% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: 3/4" Wood	**Fastener:** (2) #8 x 2-3/8" bugle-head screws, Item 30SRG
Foam: N/A	**Furring Predrill:** 3/32" dia.
Sheathing: N/A	**Remaining Material Predrill:** 1/16" dia.
Stud: Steel (33 mil)	

Test Results

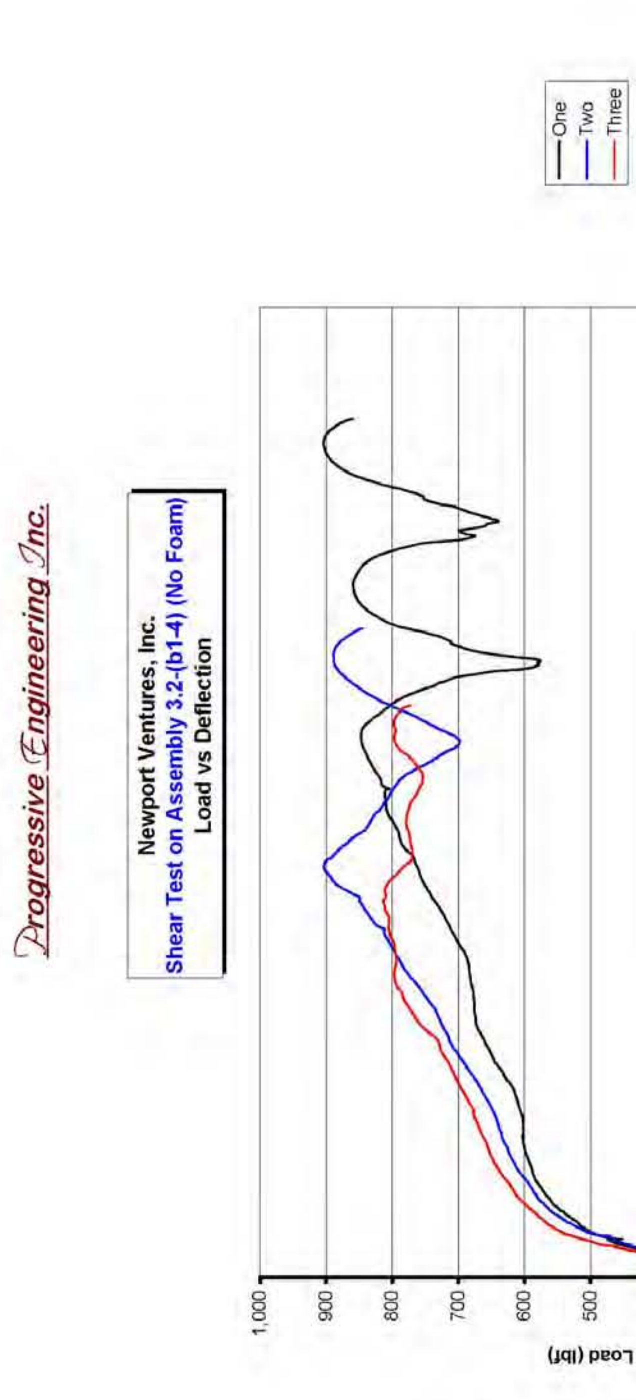
Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	904	.773"	325	602	676	759	I_M
2	904	.381"	316	630	736	898	I_M
3	814	.349"	333	658	774	814	I_M
Average	874	.501"	325	630	729	824	
COV	*6%*	*47%*	*3%*	*4%*	*7%*	*8%*	

*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.

Specimen Construction

Typical Test Set-up

Typical Failure



Progressive Engineering Inc.
Newport Ventures, Inc.
Shear Test on Assembly 3.2-(b1-4) (No Foam)
Load vs Deflection
Load (lbf)
1,000
900
800
700
600
500
400
300
200
100
0
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700
0.800
0.900
Deflection (inches)
One
Two
Three

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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 1/19/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.2-(b1-5)

Project No.: 2009-1407
Temp.: 70.0 °F
Humidity: 21% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: 3/4" Wood	**Fastener:** (2) #10 x 5" bugle-head screws, Item B10500SDRG
Foam: 2" EPS	**Furring Predrill:** 3/32" dia.
Sheathing: N/A	**Remaining Material Predrill:** 3/32" dia.
Stud: Steel (33 mil)	

Test Results

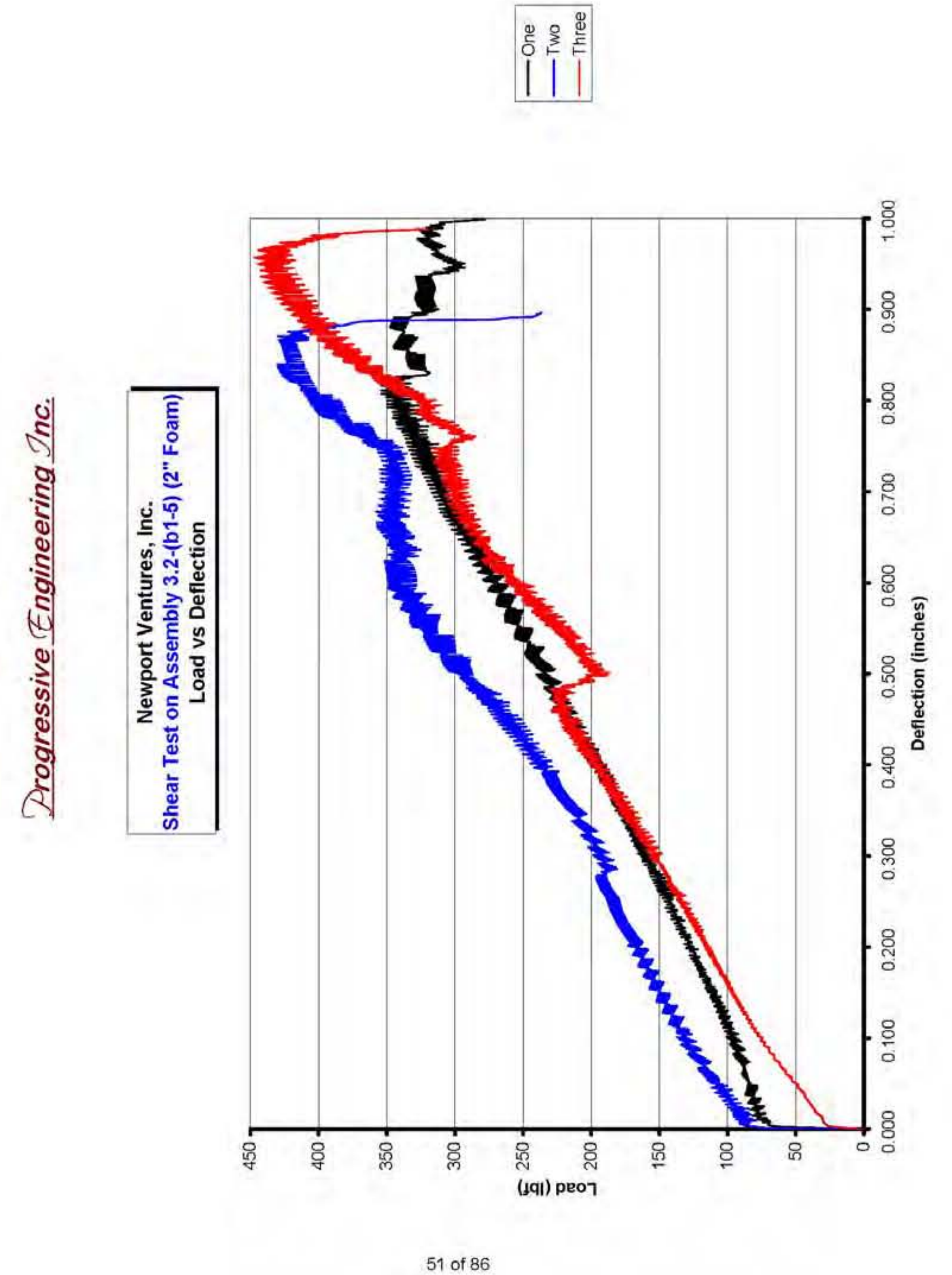
Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	354	.807"	76	102	146	182	III_M
2	430	.837"	93	141	188	221	III_M
3	447	.957"	31	85	136	189	III_M
Average	410	.867"	67	109	157	197	
COV	*12%*	*9%*	*48%*	*26%*	*18%*	*11%*	

*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.

Specimen Construction

Typical Test Set-up

Typical Failure


Progressive Engineering Inc.
Newport Ventures, Inc.
Shear Test on Assembly 3.2-(b1-5) (2" Foam)
Load vs Deflection
Load (lbf)
Deflection (inches)
One
Two
Three
0
50
100
150
200
250
300
350
400
450
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700
0.800
0.900
1.000
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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 2/25/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing (Long Term Loading)
Specimen Assembly No.: 3.2-(b2-2)

Project No.: 2009-1407
Temp.: 62.6 °F
Humidity: 34.6% R.H.
Load Rate: NA

Specimen Construction

Furring: 3/4" Wood (reduced to 3/8")	**Fastener:** (2) #10 x 5" bugle-head screws, Item B10500SDRG
Foam: 4" EPS	**Furring Predrill:** 3/32" dia.
Sheathing: N/A	**Remaining Material Predrill:** 3/32" dia.
Stud: Steel (54 mil)	

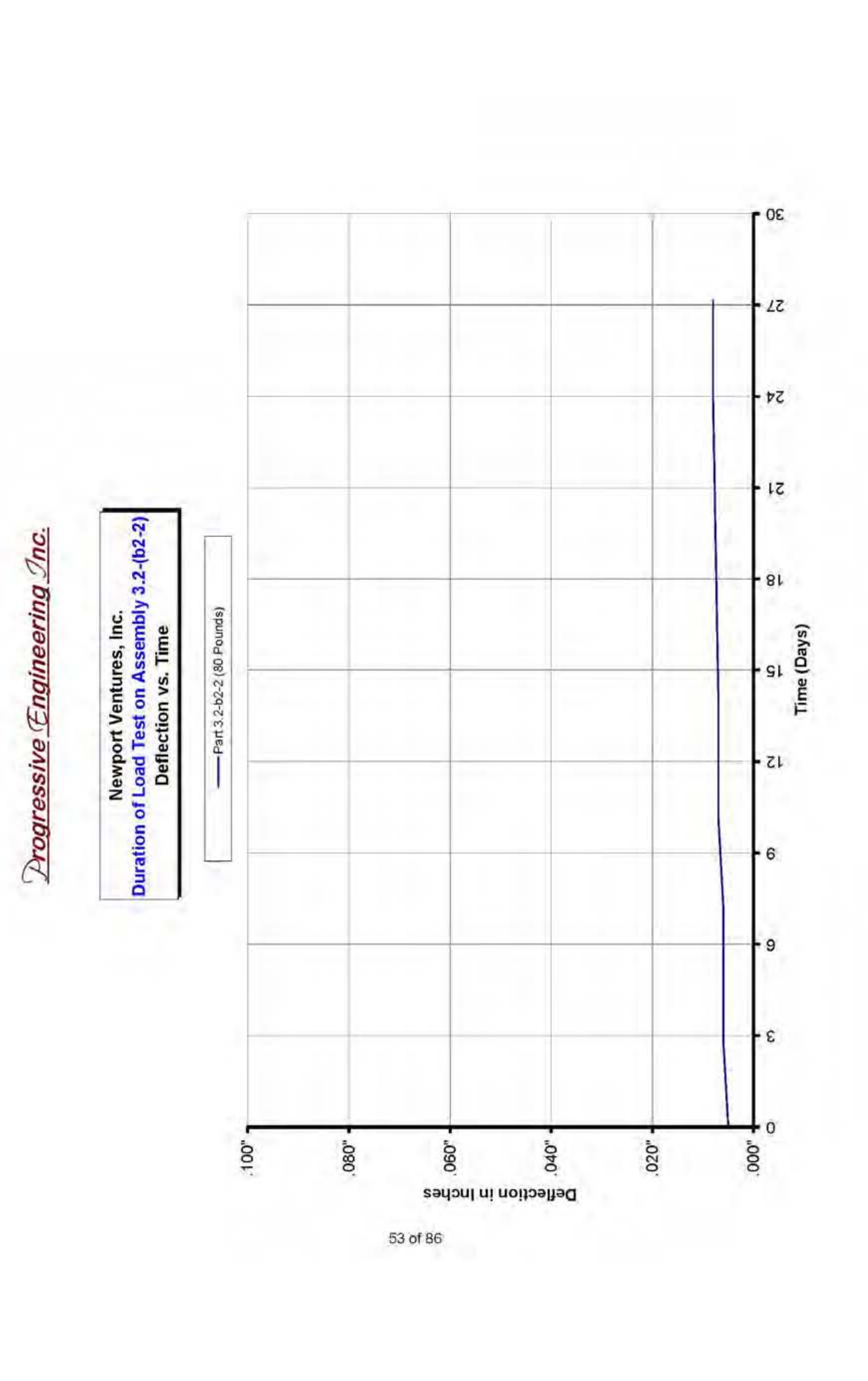
Test Results

Sample	Applied Load (lbs)	Deflection at 1 Day	Deflection at 1 Week	Deflection at 1 Month
1	80	.006"	.006"	*

* After several days without increased deflection, the testing was discontinued (see graph for details).

Typical Test Set-up

Typical Test Set-up



Progressive Engineering Inc.
Newport Ventures, Inc.
Duration of Load Test on Assembly 3.2-(b2-2)
Deflection vs. Time
Part 3.2-b2-2 (80 Pounds)
Deflection in Inches
.100"
.080"
.060"
.040"
.020"
.000"
0
3
6
9
12
15
18
21
24
27
30
Time (Days)
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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 1/28/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.2-(b2-3)

Project No.: 2009-1407
Temp.: 68.0 °F
Humidity: 21% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: 3/4" Wood (reduced to 3/8")	**Fastener:** (2) #10 x 5" bugle-head screws, Item B10500SDRG
Foam: 4" EPS	**Furring Predrill:** 3/32" dia.
Sheathing: N/A	**Remaining Material Predrill:** 3/32" dia.
Stud: Steel (54 mil)	

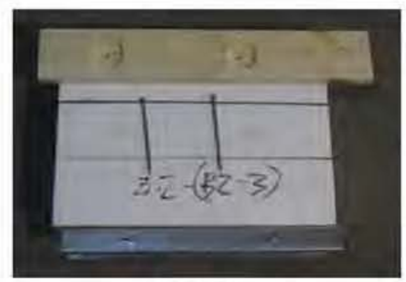
Test Results

Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	602	1.341"	150	191	239	280	II
2	580	1.501"	99	134	162	191	II
3	537	1.485"	126	148	179	216	II
Average	573	1.442"	125	158	193	229	
COV	*6%*	*6%*	*20%*	*19%*	*21%*	*20%*	

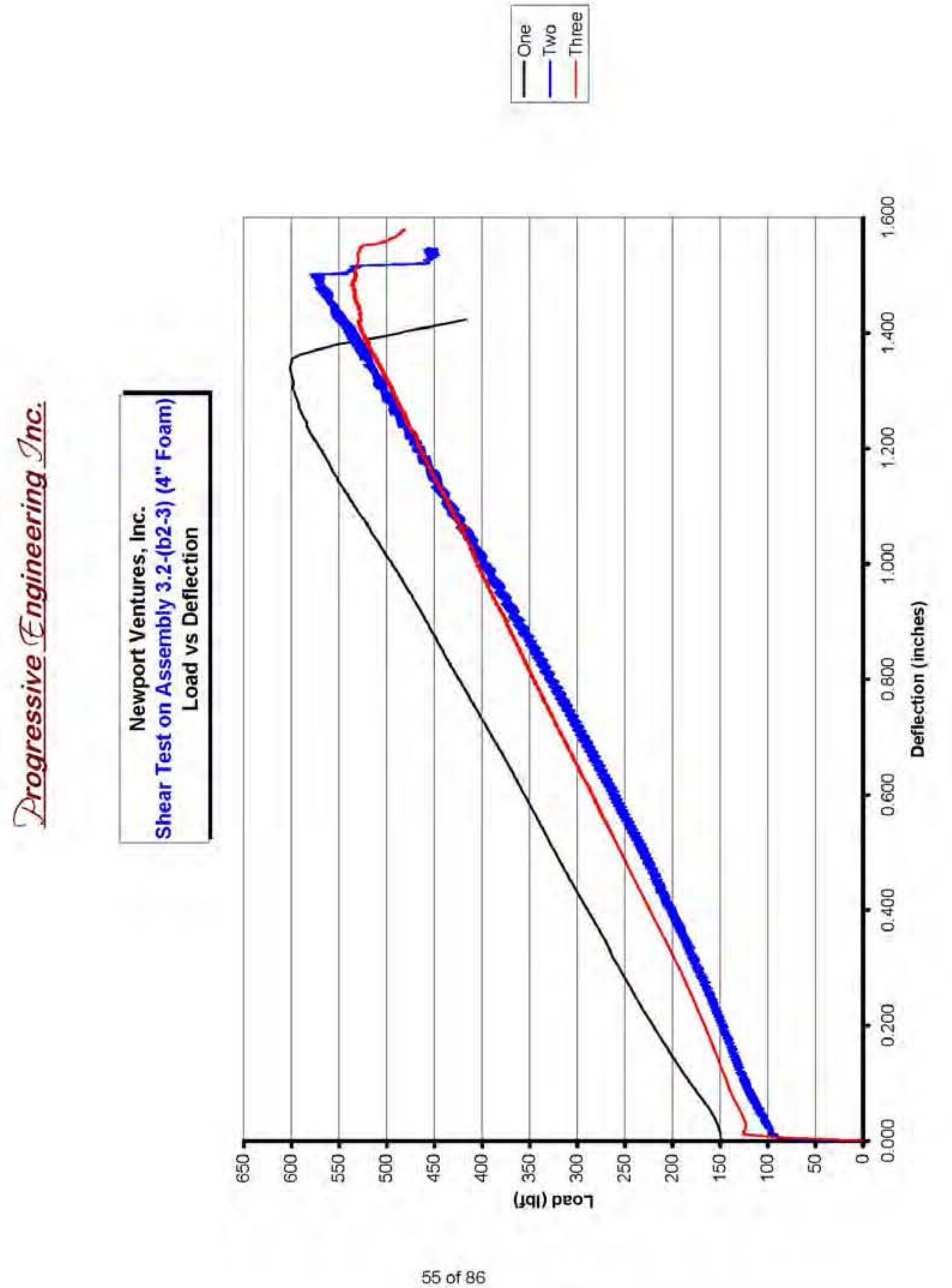
*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.

Specimen Construction

Typical Test Set-up



Typical Failure


Progressive Engineering Inc.
Newport Ventures, Inc.
Shear Test on Assembly 3.2-(b2-3) (4" Foam)
Load vs Deflection
One
Two
Three
Load (lbf)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
Deflection (inches)
0.000
0.200
0.400
0.600
0.800
1.000
1.200
1.400
1.600
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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 1/22/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.2-(b2-4)

Project No.: 2009-1407
Temp.: 69.0 °F
Humidity: 23% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: 3/4" Wood	**Fastener:** (2) #10 x 3-1/2" bugle-head screws, Item B10350SDL2RG
Foam: 2" EPS	**Furring Predrill:** 3/32" dia.
Sheathing: N/A	**Remaining Material Predrill:** 3/32" dia.
Stud: Steel (54 mil)	

Test Results

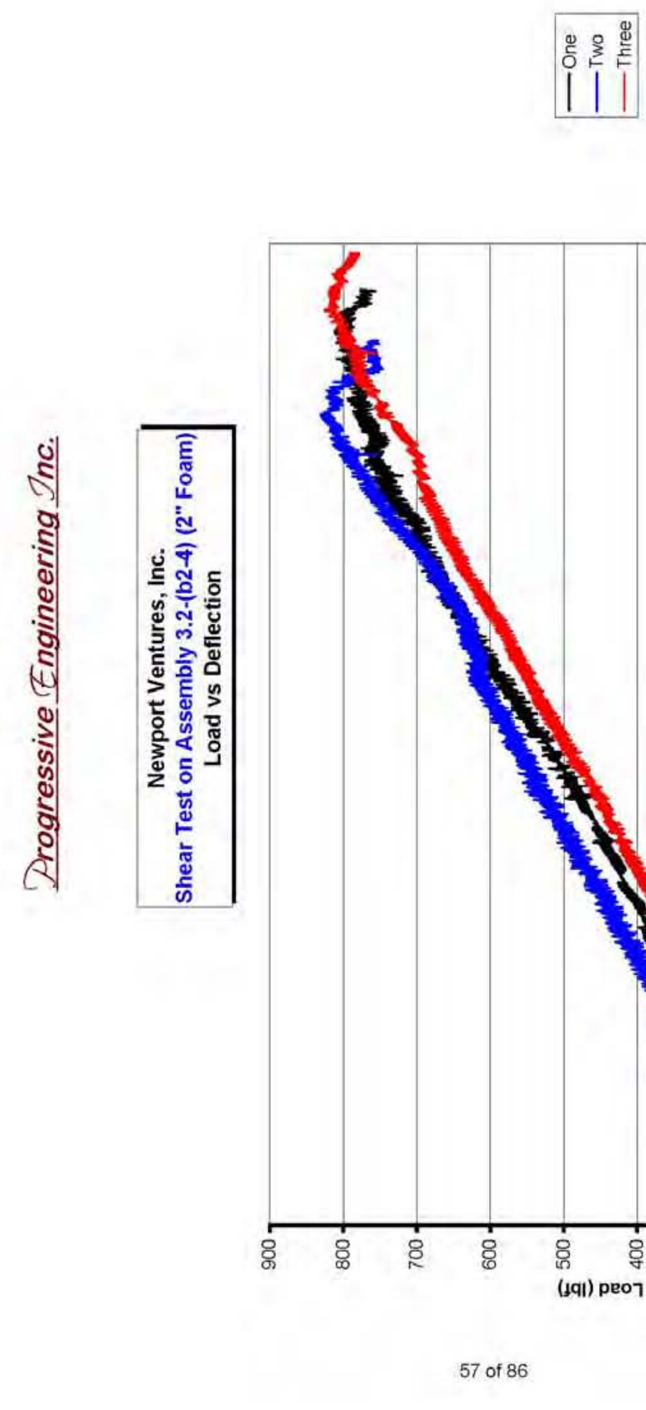
Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	812	1.635"	110	179	250	321	II
2	831	1.486"	126	215	294	362	II
3	825	1.677"	105	174	220	275	II
Average	823	1.599"	114	189	255	319	
COV	*1%*	*6%*	*10%*	*12%*	*15%*	*14%*	

*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.

Specimen Construction

Typical Test Set-up

Typical Failure


Progressive Engineering Inc.
Newport Ventures, Inc.
Shear Test on Assembly 3.2-(b2-4) (2" Foam)
Load vs Deflection
One
Two
Three
Load (lbf)
Deflection (inches)
0
100
200
300
400
500
600
700
800
900
0.000
0.200
0.400
0.600
0.800
1.000
1.200
1.400
1.600
1.800
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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 12/28/2009
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.2-(c1)

Project No.: 2009-1407
Temp.: 70.0 °F
Humidity: 21% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: 3/4" Wood	**Fastener:** (2) 0.135" x 3-1/2" 16d sinker nails
Foam: 1" EPS	**Furring Predrill:** N/A
Sheathing: N/A	**Remaining Material Predrill:** N/A
Stud: Wood 2x4	

Test Results

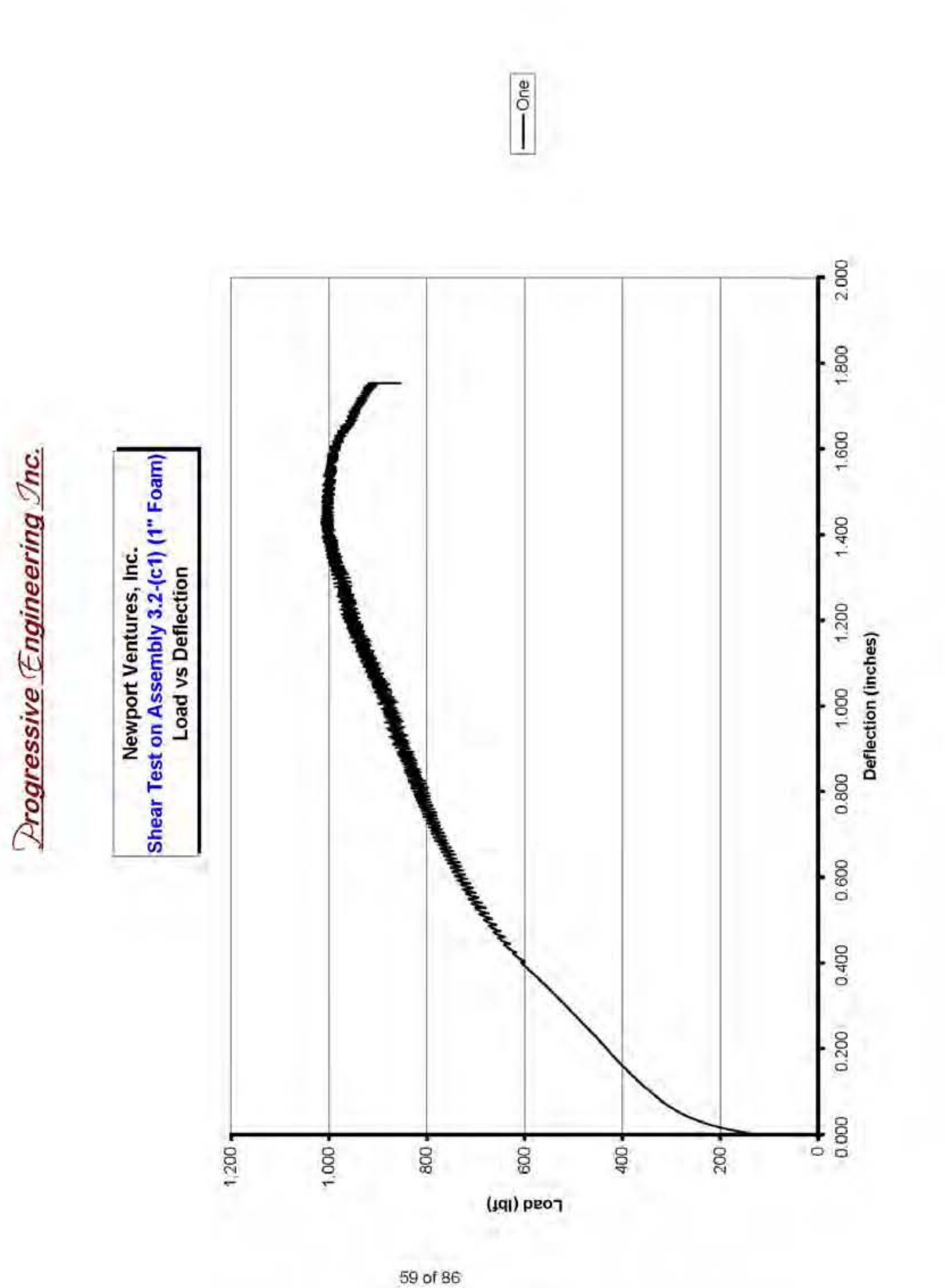
Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	1016	1.753"	196	368	473	582	IV

*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.

Specimen Construction

Typical Test Set-up

Typical Failure


Progressive Engineering Inc.
Newport Ventures, Inc.
Shear Test on Assembly 3.2-(c1) (1" Foam)
Load vs Deflection
Load (lbf)
0
200
400
600
800
1,000
1,200
Deflection (inches)
0.000
0.200
0.400
0.600
0.800
1.000
1.200
1.400
1.600
1.800
2.000
One
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Progressive Engineering Inc.

ASTM D1761 Shear Testing

Date: 12/28/2009
Client: Newport Ventures, Inc.
Test: ASTM D1761 Shear Testing
Specimen Assembly No.: 3.2-(c2)

Project No.: 2009-1407
Temp.: 70.0 °F
Humidity: 21% R.H.
Load Rate: .2" per minute

Specimen Construction

Furring: 3/4" Wood	**Fastener:** (2) 1/4" x 7" lag screws
Foam: 4" EPS	**Furring Predrill:** 1/8" dia.
Sheathing: N/A	**Remaining Material Predrill:** 15/64" dia.
Stud: Wood 2x4	

Test Results

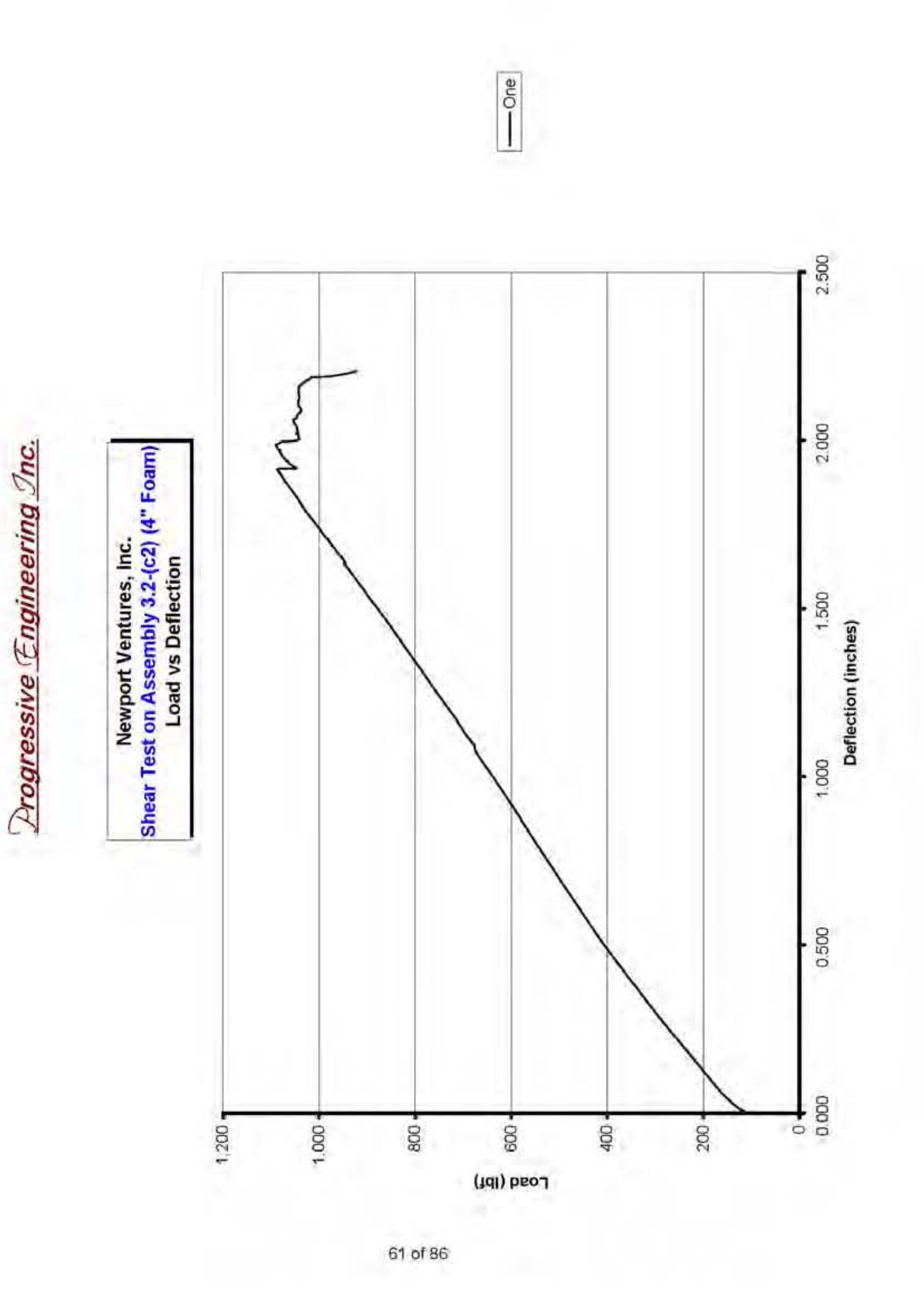
Sample	Maximum Load (lbf)	Deflection at Max. Load	Load (lbf) at: .015" Defl.	.125" Defl.	.250" Defl.	.375" Defl.	*Connection Yield Mode
1	1099	2.207"	128	202	275	343	III_s

*Based on Single Shear Connection in Figure 1 of the AF&PA, NDS, Technical Report 12.

Specimen Construction

Typical Test Set-up

Typical Failure


Progressive Engineering Inc.
Newport Ventures, Inc.
Shear Test on Assembly 3.2-(c2) (4" Foam)
Load vs Deflection
Load (lbf)
0
200
400
600
800
1,000
1,200
Deflection (inches)
0.000
0.500
1.000
1.500
2.000
2.500
One
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Progressive Engineering Inc.

ASTM D1761 Fastener Withdrawal Testing

Date: 1/28/2010
Client: Newport Ventures, Inc.
Test: ASTM D1761 Mechanical Fasteners in Wood

Project No.: 2009-1407
Temp.: 67.0 °F
Humidity: 24% R.H.
Load Rate: .1" per minute

Unit of measure = Pounds Force

	Predrilled				Not Predrilled			
	7d Nail .100" shank dia.		16d Box Nail* .134" shank dia.		7d Box Nail .100" shank dia.		16d Box Nail .134 Shank dia.	
Sample No.	7/16" OSB	3/4" OSB	7/16" OSB	3/4" OSB	7/16" OSB	3/4" OSB	7/16" OSB	3/4" OSB
1	33.5	59.4	98.4	109.9	20.7	77.8	55.9	134.9
2	37.5	53.7	89.4	183	32.3	54.1	48.4	66.3
3	35.6	63	99.5	211	43.3	91.8	66.8	93
4	39.5	72.4	81.4	146.5	33	46	51.6	112.9
5	43.4	63.9	60	172.8	30.8	39.2	67.1	92.3
6	36.9	72.1	79.9	225	59.4	65.1	45.5	100.3
Average (lbf):	37.7	64.1	84.8	174.7	36.6	62.3	55.9	100.0
COV:	9%	11%	17%	24%	36%	32%	17%	23%

Unit of measure = Pounds Force

	#8 x 3" Wood Screw (Predrilled) .124" shank dia.		1/4" x 3" Lag Screw (Predrilled) .180" shank dia.		Bright Common Nails 16d Nail (Predrilled) .160" shank dia.	
Sample No.	7/16" OSB	3/4" OSB	7/16" OSB	3/4" OSB	7/16" OSB	3/4" OSB
1	245	403	296	352	46.3	87
2	170.5	445	392	528	66.2	107
3	298	346	420	541	56.8	106.6
4	211	359	289	587	86.4	96.3
5	158	292	234	674	64.2	123.7
6	204	477	297	445	65.6	114.9
Average (lbf):	214.4	387.0	321.3	521.2	64.3	105.9
COV:	24%	18%	22%	21%	21%	12%

Note: Shank Diameter was the average measured diameter.

* Surface roughness noted.

APPENDIX

Newport Ventures, Inc.
2009-1407

Progressive Engineering Inc.

ASTM D2395-07a Specific Gravity of Wood Test

Date: 1/8/10

PEI Project No.: 2009-1407

Client: Newport Ventures, Inc.

Test Specimen: 1x4 SPF (Siding/Furring Strips)

Specimen No.	AVERAGE Size @ Test Moisture Content Width	Length	Depth	Specimen Mass (g) At Test	Oven Dry[1]	Volume[2] at Test (in^3)	Specific Gravity[3]	Moisture Content[4] (%)
3.2 A1-1	2.027"	2.965"	0.745"	38.92 g	35.75 g	4.48	0.49	9%
3.2 A1-2	2.029"	2.979"	0.746"	39.85 g	36.53 g	4.51	0.49	9%
3.2 A1-3	2.029"	2.982"	0.746"	40.89 g	37.46 g	4.51	0.51	9%
3.2 C1-1	2.032"	2.963"	0.740"	38.09 g	35.05 g	4.46	0.48	9%
3.2 C1-2	2.030"	2.987"	0.744"	37.13 g	33.71 g	4.51	0.46	10%
3.2 C1-3	2.031"	2.973"	0.743"	37.36 g	33.92 g	4.49	0.46	10%
						Average	0.48	9%

Notes: Samples cut from lumber used for siding and furring strips in Assembly Shear and Long-Term Creep Testing.

[1]- The Oven Dry weight is based on drying at 103°C until two consecutive readings, 3 hour intervals, differ less than 0.01g.

[2]- The Volume at Test is based on the average measurements taken at the original moisture content.

[3]- The Specific Gravity shown is based on the Oven-Dry mass and the Volume at Test using the constant (K=.061) as defined in Section 13.2.1 of ASTM D2395.

[4]- The Moisture Content was calculated using the equation described in Section 13.1.1 of ASTM D2395.

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Progressive Engineering Inc.

ASTM D2395-07a Specific Gravity of Wood Test

Date: 1/8/10 **PEI Project No.:** 2009-1407
Client: Newport Ventures, Inc.
Test Specimen: 2x4 SPF Framing

Specimen No.	AVERAGE Size @ Test Moisture Content Width	Length	Depth	Specimen Mass (g) At Test	Oven Dry[1]	Volume[2] at Test (in^3)	Specific Gravity[3]	Moisture Content[4] (%)
3.2 A2-1-1	2.027"	2.986"	1.459"	77.64 g	70.64 g	8.83	0.49	10%
3.2 A2-1-2	2.025"	2.992"	1.467"	76.38 g	68.89 g	8.89	0.47	11%
3.2 A2-1-3	2.020"	2.991"	1.465"	77.12 g	69.59 g	8.85	0.48	11%
3.2 C1-21	2.029"	2.912"	1.468"	64.11 g	58.64 g	8.67	0.41	9%
3.2 C1-22	2.024"	2.978"	1.488"	62.10 g	56.19 g	8.97	0.38	11%
3.2 C1-23	2.023"	2.996"	1.480"	65.19 g	58.90 g	8.97	0.40	11%
						Average	0.44	10%

Notes: Samples cut from lumber used for framing in Assembly Shear and Long-Term Creep Testing.

1 - The Oven Dry weight is based on drying at 103°C until two consecutive readings, 3 hour intervals, differ less than 0.01g.

2 - The Volume at Test is based on the average measurements taken at the original moisture content.

3 - The Specific Gravity shown is based on the Oven-Dry mass and the Volume at Test using the constant (K=.061) as defined in Section 13.2.1 of ASTM D2395.

4 - The Moisture Content was calculated using the equation described in Section 13.1.1 of ASTM D2395.

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Progressive Engineering Inc.

ASTM D2395-07a Specific Gravity of Wood Test

Date: 1/11/10

Client: Newport Ventures, Inc.

Test Specimen: 7/16" OSB

PEI Project No.: 2009-1407

Specimen No.	AVERAGE Size @ Test Moisture Content: Width	Length	Depth	Specimen Mass (g): At Test	Oven Dry[1]	Volume[2] Oven-Dry (cm^3)	Specific Gravity[3]	Moisture Content[4] (%)
A1	1.990"	3.020"	0.438"	28.94 g	27.61 g	41.89	0.66	5%
A2	1.991"	3.020"	0.433"	27.18 g	25.89 g	41.33	0.63	5%
A3	2.003"	3.020"	0.428"	29.95 g	28.52 g	41.31	0.69	5%
A11	1.992"	2.993"	0.450"	29.58 g	28.31 g	43.21	0.66	4%
A12	1.999"	2.989"	0.450"	30.20 g	28.93 g	43.22	0.67	4%
A13	1.999"	2.988"	0.446"	27.41 g	26.18 g	42.28	0.62	5%
						Average	0.65	5%

Notes: Samples cut from OSB used for Assembly Shear and Long-Term Creep Testing. Samples dipped in paraffin wax prior to volume measurement.

1- The Oven Dry weight is based on drying at 103°C until two consecutive readings, 3 hour intervals, differ less than 0.01g.

2- The Volume at Oven-Dry is based on Volume by Water Displacement (Method B-III of D2395).

3- The Specific Gravity shown is based on the Oven-Dry mass and the Volume at Test using the constant (K=1) as defined in Section 13.2.1 of ASTM D2395.

4- The Moisture Content was calculated using the equation described in Section 13.1.1 of ASTM D2395.

Progressive Engineering Inc.

ASTM D2395-07a Specific Gravity of Wood Test

Date: 1/11/10
Client: Newport Ventures, Inc.
Test Specimen: 23/32" OSB

PEI Project No.: 2009-1407

Specimen No.	AVERAGE Size @ Test Moisture Content Width	Length	Depth	Specimen Mass (g) At Test	Oven Dry[1]	Volume[2] Oven-Dry (cm^3)	Specific Gravity[3]	Moisture Content[4] (%)
B1	2.005"	3.021"	0.719"	48.88 g	46.96 g	69.21	0.68	4%
B2	2.007"	3.022"	0.713"	45.94 g	44.18 g	68.51	0.64	4%
B3	2.001"	3.024"	0.716"	47.71 g	45.73 g	68.96	0.66	4%
B11	1.999"	2.999"	0.713"	43.05 g	41.33 g	67.54	0.61	4%
B12	2.003"	3.003"	0.711"	43.93 g	42.17 g	67.58	0.62	4%
B13	1.997"	2.991"	0.711"	44.96 g	43.26 g	67.12	0.64	4%
						Average	0.64	4%

Notes: Samples cut from OSB used for Assembly Shear and Long-Term Creep Testing. Samples dipped in paraffin wax prior to volume measurement.

1- The Oven Dry weight is based on drying at 103°C until two consecutive readings, 3 hour intervals, differ less than 0.01g.

2- The Volume at Oven-Dry is based on Volume by Water Displacement (Method B-III of D2395).

3- The Specific Gravity shown is based on the Oven-Dry mass and the Volume at Test using the constant (K=1) as defined in Section 13.2.1 of ASTM D2395.

4- The Moisture Content was calculated using the equation described in Section 13.1.1 of ASTM D2395.

Progressive Engineering Inc.

ASTM C303 Foam Density Test

Date: 1/8/10 **PEI Project No.:** 2009-1407

Client: Newport Ventures, Inc.

Test Specimen: 1" EPS Foam (Type II)

Specimen No.	AVERAGE Size @ Test Moisture Content			Specimen Mass (g)		Volume[2]	Volume	Density[3]
	Width	Length	Depth	At Test	Conditioned[1]	(in^3)	(ft^3)	(lb/ft^3)
A1	4.016"	7.987"	1.022"	11.67 g	11.53 g	32.78	0.019	1.34
A2	4.018"	7.997"	1.020"	11.69 g	11.54 g	32.77	0.019	1.34
A3	4.019"	7.984"	1.021"	11.83 g	11.62 g	32.76	0.019	1.35
							Average	1.34

Notes: Samples cut from foam used in Assembly Shear and Long-Term Creep Testing.

1 - The Conditioned weight is based on equilibrium at 73°F and 50% R.H. per ASTM C578.

2 - The Volume at Test is based on the average measurements taken at the original moisture content.

3 - Density is based on Conditioned Mass. The density was converted to pounds per cubic foot as required by ASTM C578.

Progressive Engineering Inc.

ASTM C303 Foam Density Test

Date: 1/8/10

Client: Newport Ventures, Inc.

Test Specimen: 2" EPS Foam (Type II)

PEI Project No.: 2009-1407

Specimen	AVERAGE Size @ Test Moisture Content			Specimen Mass (g)		Volume[2]	Volume	Density[3]
No.	Width	Length	Depth	At Test	Conditioned[1]	(in^3)	(ft^3)	(lb/ft^3)
C1	3.994"	8.015"	1.995"	22.31 g	22.01 g	63.86	0.037	1.31
C2	3.982"	8.011"	1.996"	22.60 g	22.07 g	63.67	0.037	1.32
C3	3.984"	8.002"	1.995"	22.67 g	22.07 g	63.60	0.037	1.32
							Average	1.32

Notes: Samples cut from foam used in Assembly Shear and Long-Term Creep Testing.

1 - The Conditioned weight is based on equilibrium at 73°F and 50% R.H. per ASTM C578.

2 - The Volume at Test is based on the average measurements taken at the original moisture content.

3 - Density is based on Conditioned Mass. The density was converted to pounds per cubic foot as required by ASTM C578.

Progressive Engineering Inc.

ASTM C303 Foam Density Test

Date: 1/8/10

Client: Newport Ventures, Inc.

Test Specimen: 4" EPS Foam (Type II)

PEI Project No.: 2009-1407

Specimen	AVERAGE Size @ Test Moisture Content			Specimen Mass (g)		Volume[2]	Volume	Density[3]
No.	Width	Length	Depth	At Test	Conditioned[1]	(in^3)	(ft^3)	(lb/ft^3)
A41	4.016"	7.995"	3.972"	42.61 g	42.39 g	127.53	0.074	1.26
A42	4.022"	7.992"	3.972"	42.68 g	42.45 g	127.68	0.074	1.26
A43	4.019"	7.984"	3.968"	43.07 g	42.77 g	127.32	0.074	1.28
							Average	1.27

Notes: Samples cut from foam used in Assembly Shear and Long-Term Creep Testing.

1- The Conditioned weight is based on equilibrium at 73°F and 50% R.H. per ASTM C578.

2- The Volume at Test is based on the average measurements taken at the original moisture content.

3- Density is based on Conditioned Mass. The density was converted to pounds per cubic foot as required by ASTM C578.

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Progressive Engineering Inc.

ASTM E8 Tensile Test

Date: 1/29/2010

Project No.: 2009-1407

Client: Newport Ventures, Inc.

Specimen: Steel Coupons. See Below

Test: ASTM E8 Tensile Test

					Tensile Yield Strength		Tensile Ultimate	
Sample ID	Sample No.	Width (in)	Thickness (in)	Area (in²)	OS @ .2 (lbf)	OS @ .2 (psi)	Ultimate (lbf)	Ultimate (psi)
33 mil stud	1	.483	.032	.01546	328	21,222	727	47,037
33 mil stud	2	.499	.031	.01547	319	20,622	754	48,743
33 mil stud	3	.500	.031	.01550	344	22,194	754	48,645
54 mil stud	1	.507	.053	.02687	1492	55,525	1824	67,880
54 mil stud	2	.502	.054	.02711	1463	53,969	1801	66,438
54 mil stud	3	.503	.054	.02716	1500	55,224	1833	67,484
33 mil hat channel	1	.500	.034	.01700	1195	70,294	1381	81,235
33 mil hat channel	2	.497	.034	.01690	1173	69,416	1384	81,903
33 mil hat channel	3	.494	.034	.01680	1164	69,302	1379	82,103

Progressive Engineering Inc.

ASTM F1575 Fastener Bending Yield Moment

Date: 2/2/2010 **Project No.:** 2009-1407

Client: Newport Ventures, Inc.

Fastener: 16D Hot Dipped Box Nails*

Measured Fastener Dimensions

Ten Specimen Average (inch)		
Shank Dia.	Head Dia.	Length
.142 / .134	.347 / .345	3.542 / 3.535

* Measurements taken before and after the galvanized layer was removed.

Fastener Bending Yield Moment

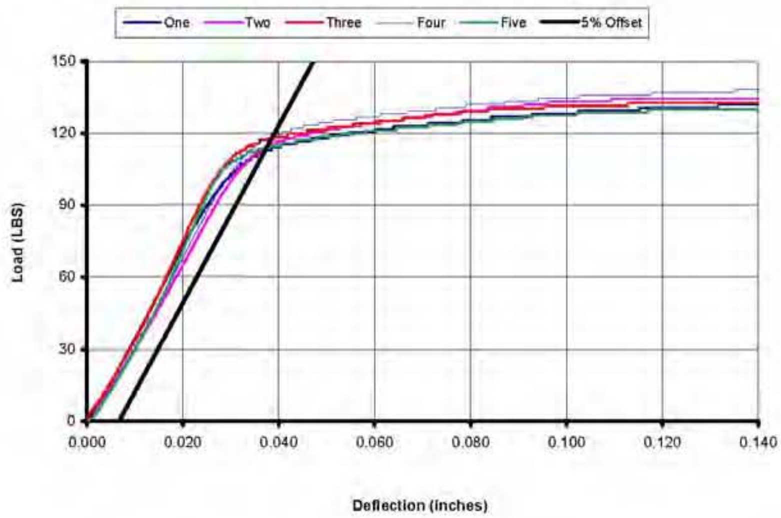
Test Span (in)= 1.5

Load Rate = .25"/min

Sample No.	Yield Load P (lbf)[1]	Yield Strength F_{yb} (psi)[2]
1	111	103,799
2	114	106,604
3	117	109,409
4	118	110,344
5	115	107,539
Average	**115**	**107,539**
COV	*2.4%*	*2.4%*

[1]- Fastener Yield Load is derived from the load/deflection curve at a point offset 5% of the fastener diameter, as described in Section 10 of ASTM F1575.

[2]- Fastener Yield Strength is calculated with the equation found in Annex A1 of ASTM F1575 using the average shank diameter.



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Progressive Engineering Inc.

ASTM F1575 Fastener Bending Yield Moment

Date: 2/2/2010

Project No.: 2009-1407

Client: Newport Ventures, Inc.

Fastener: 7d Box Nails

Measured Fastener Dimensions

Ten Specimen Average (inch)		
Shank Dia.	**Head Dia.**	**Length**
0.100	0.244	2.323

Fastener Bending Yield Moment

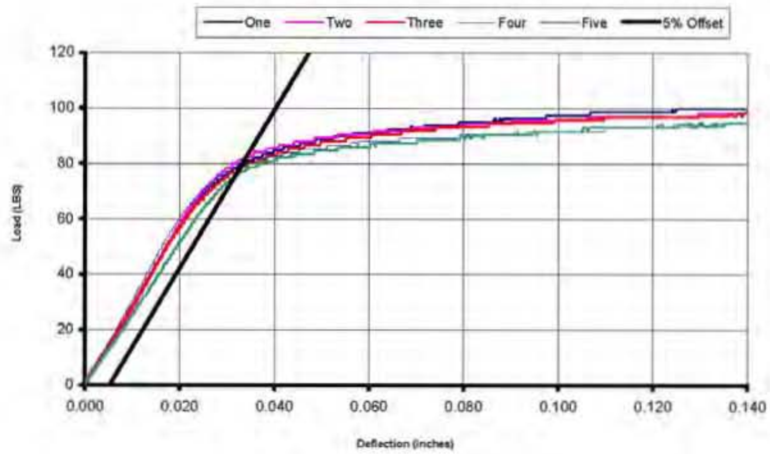
Test Span (in)= 1.1

Load Rate = .25"/min

Sample No.	Yield Load P (lbf)[1]	Yield Strength F_{yb} (psi)[2]
1	83	136,950
2	80	132,000
3	78	128,700
4	79	130,350
5	75	123,750
Average	**79**	**130,350**
COV	*3.7%*	*3.7%*

[1]- Fastener Yield Load is derived from the load/deflection curve at a point offset 5% of the fastener diameter, as described in Section 10 of ASTM F1575.

[2]- Fastener Yield Strength is calculated with the equation found in Annex A1 of ASTM F1575 using the average shank diameter.



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Progressive Engineering Inc.

ASTM F1575 Fastener Bending Yield Moment

Date: 2/2/2010 **Project No.:** 2009-1407
Client: Newport Ventures, Inc.

Fastener: 10 Ga x 4" Long Maze Foundry Nail

Measured Fastener Dimensions

Ten Specimen Average (inch)		
Shank Dia.	Head Dia.	Length
0.135	0.362	4.067

* Measurements taken before and after the galvanized layer was removed.

Fastener Bending Yield Moment

NOTE: Insufficient fasteners available for Bending Yield Testing. See 10 Ga x 6" Long Maze Foundry Nails for Comparable Results.

Progressive Engineering Inc.

ASTM F1575 Fastener Bending Yield Moment

Date: 2/2/2010 **Project No.:** 2009-1407

Client: Newport Ventures, Inc.

Fastener: 10 Ga x 6" Long Maze Foundry Nail

Measured Fastener Dimensions

Ten Specimen Average (inch)		
Shank Dia.	**Head Dia.**	**Length**
0.135	0.337	6.047

* Measurements taken before and after the galvanized layer was removed.

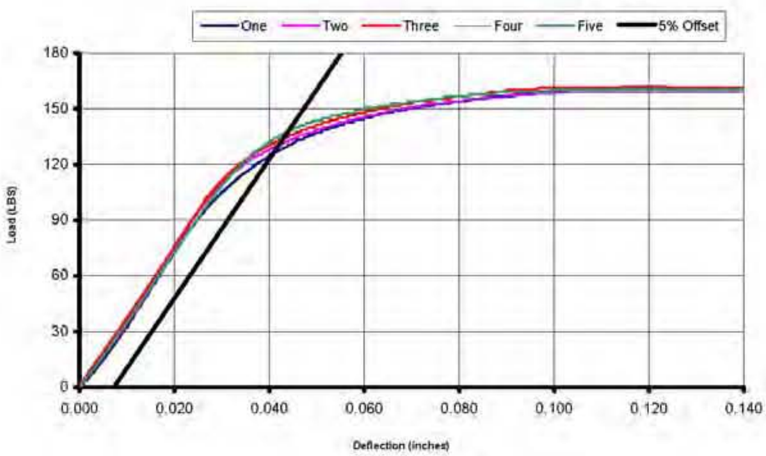
Fastener Bending Yield Moment

Test Span (in)= 1.5
Load Rate = .25"/min

Sample No.	Yield Load P (lbf)[1]	Yield Strength F_{yb} (psi)[2]
1	127	116,141
2	131	119,799
3	135	123,457
4	127	116,141
5	138	126,200
Average	**132**	**120,348**
COV	*3.7%*	*3.7%*

[1]- Fastener Yield Load is derived from the load/deflection curve at a point offset 5% of the fastener diameter, as described in Section 10 of ASTM F1575.

[2]- Fastener Yield Strength is calculated with the equation found in Annex A1 of ASTM F1575 using the average shank diameter.



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Progressive Engineering Inc.

ASTM F1575 Fastener Bending Yield Moment

Date: 2/2/2010
Client: Newport Ventures, Inc.

Project No.: 2009-1407

Fastener: #8 x 1-1/2" Standard Wood Screws

Measured Fastener Dimensions

Ten Specimen Average (inch)				
Root Dia.	Thread Dia.	Length	Shoulder Dia.	Head Dia.
0.111	0.157	1.480	0.121	0.303

Fastener Bending Yield Moment

NOTE: The wood screw was too short to be tested at the 1.1" required span.

Progressive Engineering Inc.

ASTM F1575 Fastener Bending Yield Moment

Date: 2/2/2010 **Project No.:** 2009-1407

Client: Newport Ventures, Inc.

Fastener: #8 x 2" Standard Wood Screws

Measured Fastener Dimensions

Ten Specimen Average (inch)				
Root Dia.	**Thread Dia.**	**Length**	**Shoulder Dia.**	**Head Dia.**
0.106	0.165	1.972	0.121	0.301

Fastener Bending Yield Moment

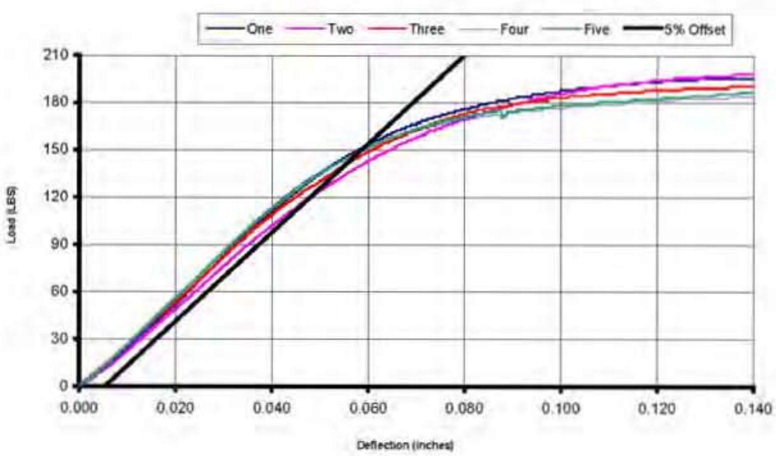
Test Span (in)= 1.1

Load Rate = .25"/min

Sample No.	Yield Load P (lbf)[1]	Yield Strength F_{yb} (psi)[2]
1	152	210,577
2	147	203,650
3	140	193,952
4	149	206,420
5	149	206,420
Average	**147**	**204,204**
COV	*3.1%*	*3.1%*

[1]- Fastener Yield Load is derived from the load/deflection curve at a point offset 5% of the fastener diameter, as described in Section 10 of ASTM F1575.

[2]- Fastener Yield Strength is calculated with the equation found in Annex A1 of ASTM F1575 using the average root diameter or the average shoulder diameter, based on the location of the loading nose.



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Progressive Engineering Inc.

ASTM F1575 Fastener Bending Yield Moment

Date: 2/22/2010

Project No.: 2009-1407

Client: Newport Ventures, Inc.

Fastener: #8 x 3" Standard Wood Screws

Measured Fastener Dimensions

Ten Specimen Average (inch)				
Root Dia.	**Thread Dia.**	**Length**	**Shoulder Dia.**	**Head Dia.**
0.115	0.160	2.977	0.126	0.305

Fastener Bending Yield Moment

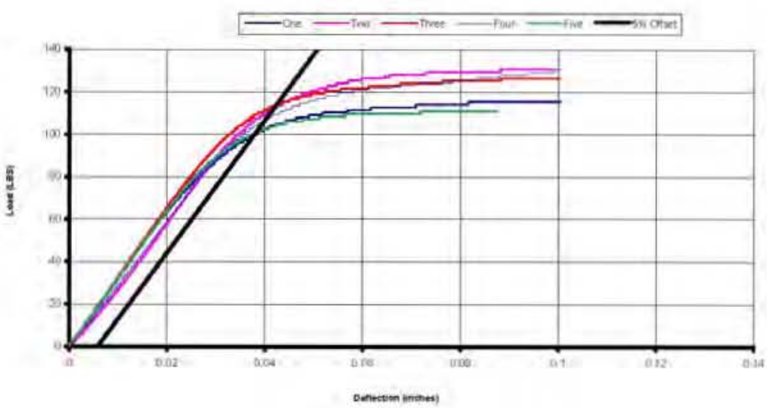
Test Span (in)= 1.1

Load Rate = .25"/min

Sample No.	Yield Load P (lbf)[1]	Yield Strength F_{yb} (psi)[2]
1	100	108,490
2	111	120,424
3	114	123,679
4	106	115,000
5	99	107,405
Average	**106**	**115,000**
COV	*6.2%*	*6.2%*

1- Fastener Yield Load is derived from the load/deflection curve at a point offset 5% of the fastener diameter, as described in Section 10 of ASTM F1575.

2- Fastener Yield Strength is calculated with the equation found in Annex A1 of ASTM F1575 using the average root diameter or the average shoulder diameter, based on the location of the loading nose.



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Progressive Engineering Inc.

ASTM F1575 Fastener Bending Yield Moment

Date: 2/2/2010 **Project No.:** 2009-1407

Client: Newport Ventures, Inc.

Fastener: 1/4" x 2" Hex Head Lag

Measured Fastener Dimensions

Ten Specimen Average (inch)				
Root Dia.	**Thread Dia.**	**Length**	**Shoulder Dia.**	**Head Size***
0.182	0.242	1.974	0.238	0.429

*-Perpendicular dimension from opposing flat surfaces on hexagon head.

Fastener Bending Yield Moment

NOTE: The lag screw was too short to be tested at the 2.2" required span.

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Progressive Engineering Inc.

ASTM F1575 Fastener Bending Yield Moment

Date: 2/2/2010 **Project No.:** 2009-1407

Client: Newport Ventures, Inc.

Fastener: 1/4" x 3" Hex Head Lag

Measured Fastener Dimensions

Ten Specimen Average (inch)				
Root Dia.	**Thread Dia.**	**Length**	**Shoulder Dia.**	**Head Size***
0.180	0.247	2.975	0.241	0.431

*-Perpendicular dimension from opposing flat surfaces on hexagon head.

Fastener Bending Yield Moment

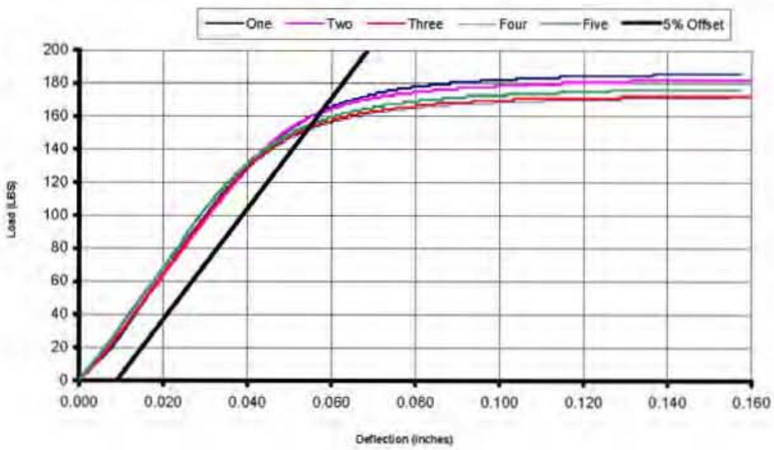
Test Span (in)= 2.2

Load Rate = .25"/min

Sample No.	Yield Load P (lbf)[1]	Yield Strength F_{yb} (psi)[2]
1	163	92,233
2	162	91,667
3	153	86,574
4	150	84,877
5	156	88,272
Average	**157**	**88,724**
COV	*3.6%*	*3.6%*

[1]- Fastener Yield Load is derived from the load/deflection curve at a point offset 5% of the fastener diameter, as described in Section 10 of ASTM F1575.

[2]- Fastener Yield Strength is calculated with the equation found in Annex A1 of ASTM F1575 using the average root diameter or the average shoulder diameter, based on the location of the loading nose.



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Progressive Engineering Inc.

ASTM F1575 Fastener Bending Yield Moment

Date: 2/2/2010 **Project No.:** 2009-1407

Client: Newport Ventures, Inc.

Fastener: 1/4" x 4" Hex Head Lag

Measured Fastener Dimensions

Ten Specimen Average (inch)				
Root Dia.	**Thread Dia.**	**Length**	**Shoulder Dia.**	**Head Size***
0.178	0.245	3.944	0.234	0.431

*-Perpendicular dimension from opposing flat surfaces on hexagon head.

Fastener Bending Yield Moment

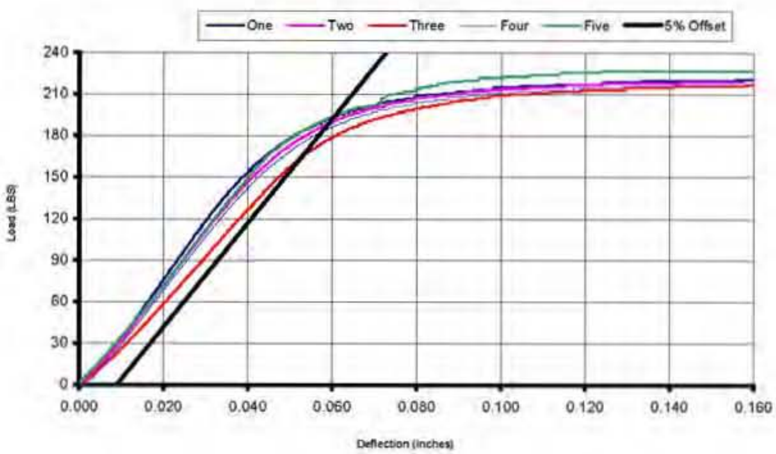
Test Span (in)= 2.2

Load Rate = .25"/min

Sample No.	Yield Load P (lbf)[1]	Yield Strength F_{yb} (psi)[2]
1	193	112,930
2	188	110,005
3	183	107,079
4	182	106,494
5	195	114,101
Average	**188**	**110,122**
COV	*3.1%*	*3.1%*

[1]- Fastener Yield Load is derived from the load/deflection curve at a point offset 5% of the fastener diameter, as described in Section 10 of ASTM F1575.

[2]- Fastener Yield Strength is calculated with the equation found in Annex A1 of ASTM F1575 using the average root diameter or the average shoulder diameter, based on the location of the loading nose.



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Progressive Engineering Inc.

ASTM F1575 Fastener Bending Yield Moment

Date: 2/2/2010 **Project No.:** 2009-1407

Client: Newport Ventures, Inc.

Fastener: 1/4" x 6" Hex Head Lag

Measured Fastener Dimensions

Ten Specimen Average (inch)				
Root Dia.	Thread Dia.	Length	Shoulder Dia.	Head Size*
0.181	0.249	6.099	0.239	0.431

*-Perpendicular dimension from opposing flat surfaces on hexagon head.

Fastener Bending Yield Moment

Test Span (in)= 2.2

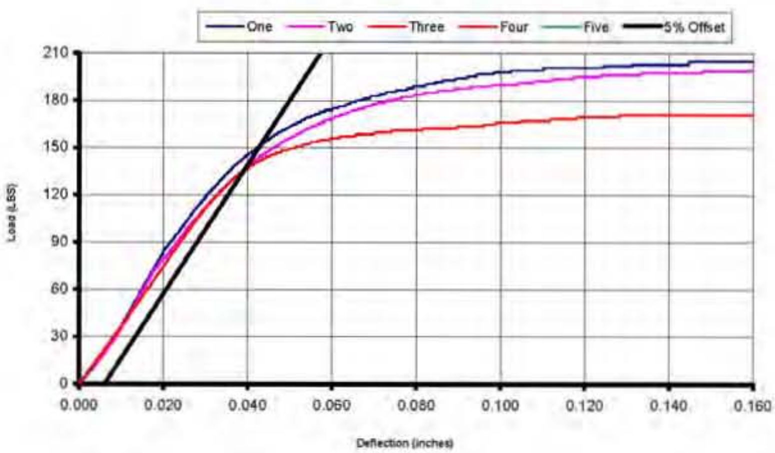
Load Rate = .25"/min

Sample No.	Yield Load P (lbf)[1]	Yield Strength F_{yb} (psi)[2]
1	151	84,034
2	137	76,243
3	136	75,686
4		
5		
Average	**141**	**78,654**
COV	*5.9%*	*5.9%*

NOTE: Insufficient fasteners available for a complete set of Fastener Bending Tests.

[1]- Fastener Yield Load is derived from the load/deflection curve at a point offset 5% of the fastener diameter, as described in Section 10 of ASTM F1575.

[2]- Fastener Yield Strength is calculated with the equation found in Annex A1 of ASTM F1575 using the average root diameter or the average shoulder diameter, based on the location of the loading nose.



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Progressive Engineering Inc.

ASTM F1575 Fastener Bending Yield Moment

Date: 2/2/2010 **Project No.:** 2009-1407

Client: Newport Ventures, Inc.

Fastener: 1/4" x 7" Hex Head Lag

Measured Fastener Dimensions

Ten Specimen Average (inch)				
Root Dia.	Thread Dia.	Length	Shoulder Dia.	Head Size*
0.179	0.247	7.049	0.239	0.432

*-Perpendicular dimension from opposing flat surfaces on hexagon head.

Fastener Bending Yield Moment

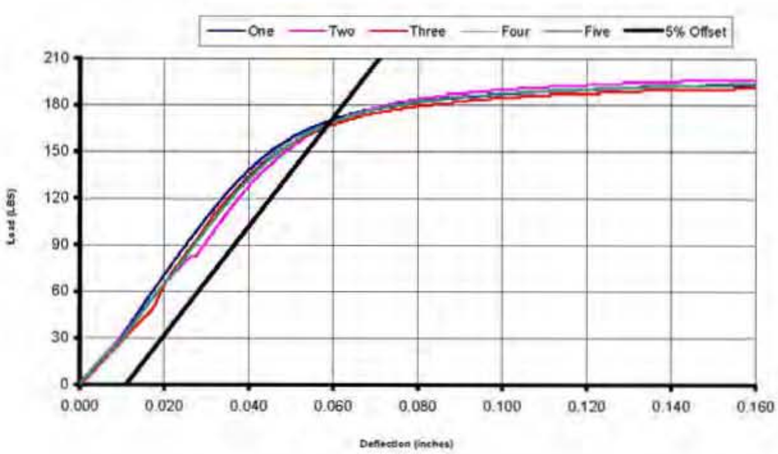
Test Span (in)= 2.2

Load Rate = .25"/min

Sample No.	Yield Load P (lbf)[1]	Yield Strength F_{yb} (psi)[2]
1	170	97,815
2	166	95,513
3	166	95,513
4	169	97,239
5	167	96,088
Average	**168**	**96,434**
COV	*1.1%*	*1.1%*

[1]- Fastener Yield Load is derived from the load/deflection curve at a point offset 5% of the fastener diameter, as described in Section 10 of ASTM F1575.

[2]- Fastener Yield Strength is calculated with the equation found in Annex A1 of ASTM F1575 using the average root diameter or the average shoulder diameter, based on the location of the loading nose.



Progressive Engineering Inc.

ASTM F1575 Fastener Bending Yield Moment

Date: 2/2/2010 **Project No.:** 2009-1407

Client: Newport Ventures, Inc.

Fastener: **#8 x 2-3/8" Long self-drilling, Grabber Screw**

Measured Fastener Dimensions

Ten Specimen Average (inch)				
Root Dia.	**Thread Dia.**	**Length**	**Shoulder Dia.**	**Head Dia.**
0.108	0.159	2.345	0.131	0.325

Fastener Bending Yield Moment

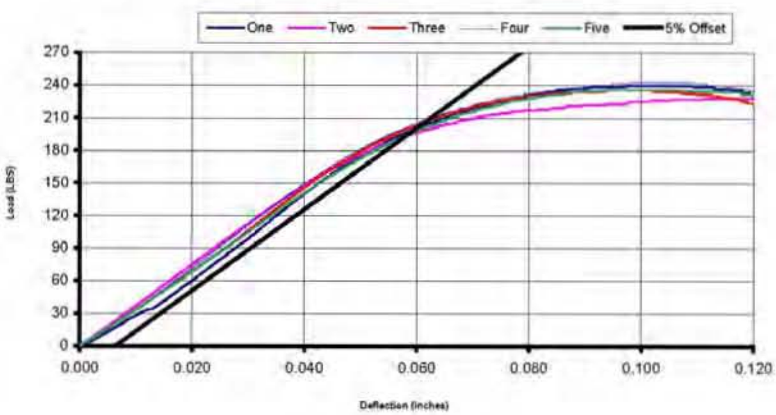
Test Span (in)= 1.1

Load Rate = .25"/min

Sample No.	Yield Load P (lbf)[1]	Yield Strength F_{yb} (psi)[2]
1	200	261,965
2	193	252,796
3	206	269,824
4	209	273,753
5	193	252,796
Average	**200**	**262,227**
COV	*3.7%*	*3.7%*

1- Fastener Yield Load is derived from the load/deflection curve at a point offset 5% of the fastener diameter, as described in Section 10 of ASTM F1575.

2- Fastener Yield Strength is calculated with the equation found in Annex A1 of ASTM F1575 using the average root diameter or the average shoulder diameter, based on the location of the loading nose.



Progressive Engineering Inc.

ASTM F1575 Fastener Bending Yield Moment

Date: 2/2/2010 **Project No.:** 2009-1407

Client: Newport Ventures, Inc.

Fastener: **#10 x 3.5" Long self-drilling, Grabber Screw**

Measured Fastener Dimensions

Ten Specimen Average (inch)				
Root Dia.	Thread Dia.	Length	Shoulder Dia.	Head Dia.
0.131	0.184	3.486	0.151	0.341

Fastener Bending Yield Moment

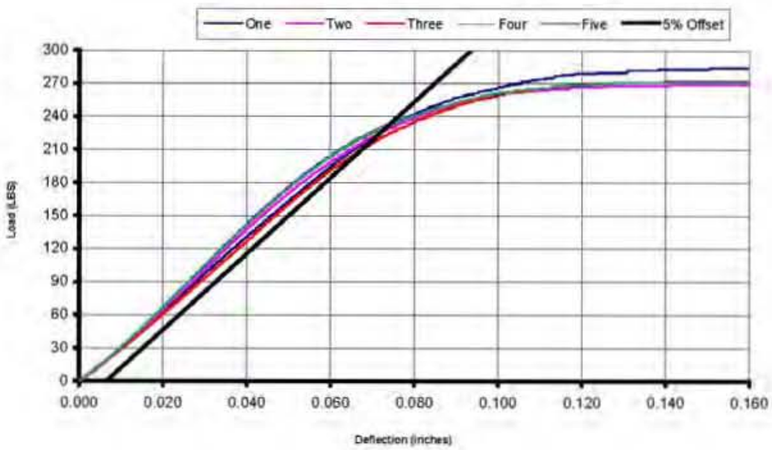
Test Span (in)= 1.5

Load Rate = .25"/min

Sample No.	Yield Load P (lbf)[1]	Yield Strength F_{yb} (psi)[2]
1	225	225,191
2	225	225,191
3	224	224,190
4	235	235,200
5	231	231,196
Average	**228**	**228,194**
COV	*2.1%*	*2.1%*

[1]- Fastener Yield Load is derived from the load/deflection curve at a point offset 5% of the fastener diameter, as described in Section 10 of ASTM F1575.

[2]- Fastener Yield Strength is calculated with the equation found in Annex A1 of ASTM F1575 using the average root diameter or the average shoulder diameter, based on the location of the loading nose.



Progressive Engineering Inc.

ASTM F1575 Fastener Bending Yield Moment

Date: 2/2/2010 **Project No.:** 2009-1407

Client: Newport Ventures, Inc.

Fastener: **#10 x 5" Long self-drilling, Grabber Screw**

Measured Fastener Dimensions

Ten Specimen Average (inch)				
Root Dia.	**Thread Dia.**	**Length**	**Shoulder Dia.**	**Head Dia.**
0.130	0.185	4.986	0.151	0.342

Fastener Bending Yield Moment

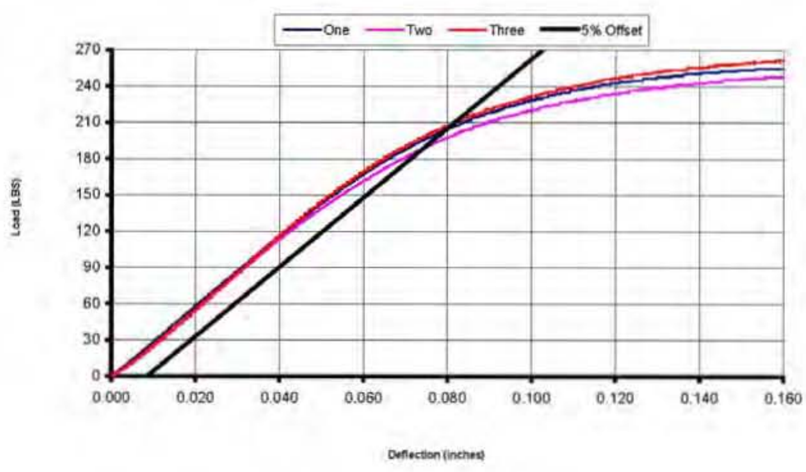
Test Span (in)= 1.9
Load Rate = .25"/min

Sample No.	Yield Load P (lbf)[1]	Yield Strength F_{yb} (psi)[2]
1	203	263,336
2	187	242,581
3	208	269,822
4	-	-
5	-	-
Average	**199**	**258,580**
COV	*5.5%*	*5.5%*

NOTE: Insufficient fasteners available for a complete set of Fastener Bending Tests.

[1]- Fastener Yield Load is derived from the load/deflection curve at a point offset 5% of the fastener diameter, as described in Section 10 of ASTM F1575.

[2]- Fastener Yield Strength is calculated with the equation found in Annex A1 of ASTM F1575 using the average root diameter or the average shoulder diameter, based on the location of the loading nose.



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Fastening Systems for Continuous Insulation

Final Report 10-11

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