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BUILDING TECHNOLOGIES PROGRAM

Results From Development of Model Specifications for Multifamily Energy Retrofits

Kevin Brozyna
IBACOS, Inc

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Prepared for:

Building America

Building Technologies Program

Office of Energy Efficiency and Renewable Energy

U.S. Department of Energy

Prepared by:

Kevin Brozyna

IBACOS, Inc.

2214 Liberty Avenue

Pittsburgh, PA 15222

NREL Technical Monitor: Michael Gestwick

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Unless otherwise noted, all figures were created by IBACOS.

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Definitions

ACCA	Air Conditioning Contractors of America
AIA	American Institute of Architects
CDBG	Community Development Block Grant
CNA	Capital Needs Assessment
CSI	Construction Specification Institute
DOE	U.S. Department of Energy
EGC	Enterprise Green Communities
EGCC	Enterprise Green Communities Criteria
GRP	Green Retrofit Program
HERS	Home Energy Rating System
HTF	Housing Trust Fund
HUD	U.S. Department of Housing and Urban Development
HVAC	Heating, Ventilation, and Air-Conditioning
LEED	Leadership in Energy and Environmental Design
LIHEAP	Low Income Home Energy Assistance Program
LIHTC	Low Income Housing Tax Credit
MPP	Multifamily Building Performance Program
NYSERDA	New York State Energy Research and Development Authority
OAHP	HUD Office of Affordable Housing Preservation
PNA	Physical Needs Assessment
QAP	Qualified Allocation Plan
SEA	Self Energy Audit
USGBC	U.S. Green Building Council

Executive Summary

An increasingly common trend has been emerging in the development and rehabilitation of low-income, multifamily building projects. Federal and state housing agencies have recognized the need to make these types of housing units more energy efficient and, in turn, more cost effective for the occupants to operate. Developers and building owners, required to incorporate energy efficiency measures into their buildings, are looking for ways to standardize the processes and building practices that their contractors will use to execute the measures. Modifying model specifications to include guidance on energy efficiency measures is one approach that developers such as Mercy Housing of Denver, Colorado, are using to support their project teams.

Model specifications are documents used throughout the construction industry as a means of describing and communicating information about the building systems and components being installed. Using the Construction Specification Institute (CSI) MasterFormat number system (CSI 2011), these documents contain standardized formatting and language to communicate specific technical requirements and recommendations of the building systems and components to the trade contractors and builders executing the work.

Mercy Housing is a national nonprofit organization that works to improve neighborhoods by providing services for the development, preservation, management, and affordable financing for housing projects, with the intent of improving the economic status of residents, revitalizing neighborhoods, and stabilizing lives. Mercy Housing has ongoing projects in each of the major U.S. Department of Energy (DOE) climate zones, with multiple building types present throughout all of those zones. Thus, each division of Mercy Housing has operated under a decentralized organizational structure. Each individual region develops its own approach to specifying building practices, products, and systems for use in its projects.

Mercy Housing partnered with IBACOS to review the model specification documents related to energy efficiency and building that Mercy Housing currently uses for its new construction and retrofit projects in multiple climate zones. IBACOS added content to the specification documents that discusses the system interactions, risks, energy efficiency, durability, and health and safety implications of the individual specification in relation to the building systems and project as a whole. Mercy Housing selected these specifications for IBACOS to revise due to requests from the Mercy Housing design teams for greater guidance and specificity to the mostly generic content of their existing specifications related to energy efficiency, building durability, space conditioning equipment, and renewable energy technology.

The development and revisions of these model specification documents provided more clarity and guidance for the general contractor and trades. The goal was to create a greater level of understanding of the risks and implications associated with the measures and consistency in execution of energy efficiency retrofit measures across the multiple regions where a developer may work. While these specifications assume that the design team is familiar with and understands basic building science principles, notes and

comments have been incorporated as sidebars in the specifications to provide additional information that the designer should consider when determining whether the specification is appropriate for a particular project. The model specifications are intended to be revised and modified as needed for use, depending on the particular needs and conditions of a project. The sidebar notes and comments added to these model specifications are solely intended for the use of the building design team and should be removed from the specification documents prior to providing those specifications, as part of the construction documentation, to the general contractor and trades.

Contractors use plan sets to complete takeoffs and to construct a building. The purpose of the specifications is to complement the construction drawings in a bid package for the general contractor. The specifications also outline the best practice recommendations for selecting the appropriate components and materials needed to execute the building assembly details specified on the construction drawings and documentation.

Based on input from Mercy Housing, IBACOS developed these sample model specifications using a common building construction type that Mercy Housing encounters on many of its projects in the cold climate zone. Mercy Housing typically works with building characteristics such as buildings that are three stories or fewer; 2x4 or 2x6 wood-framed insulated walls fully covered with exterior sheathing; housewrap; siding; and wood-framed (stick or truss) roof systems with asphalt composition shingles. The specifications selected to be revised as models were based on the building energy efficiency measures most commonly addressed by Mercy Housing divisions: building insulation, building durability, space conditioning systems, and on-site renewable energy generation.

As the demand for and cost of energy continues to rise in the United States, cost-effective approaches must be found to ensure that affordable housing is truly affordable for low-income families. Model specifications that emphasize cost-effective approaches for the implementation of energy efficiency, durability, and health and safety measures can enable developers to provide clarity and guidance to their trade partners on the implementation of such measures. Ultimately, the goal of the model specifications is to create a greater level of consistency in executing energy efficiency retrofit measures across the multiple regions where a developer may work.

1 Introduction

Historically, multifamily affordable housing projects have been subsidized by federal and state programs to provide low-cost housing options for low-income families. An increasingly common trend toward improving energy efficiency and performance has been emerging in the development and rehabilitation of low-income, multifamily building projects. Agencies responsible for disseminating federal and state funds for low-income, multifamily rehabilitation work have recognized as a priority the need to make these types of housing units more energy efficient and, in turn, more cost effective for occupants to operate. Typically these federal and state agencies will establish minimum energy efficiency or green building requirements for the developers to incorporate into their designs when applying for project funding. Rather than developing efficiency standards of their own, the agencies commonly will require the developers to comply with established standards and certification programs to qualify for funding or will set voluntary performance measures that, if included, will result in preferential review of the developer's application. For example, New York State's Division of Housing and Community Renewal through the Housing Trust Fund Corporation (HTF) and HOME Program offers points on developer applications, depending on the level to which the developer incorporates and agrees to participate in the Energy Star for Homes v. 3.0 program or the New York State Energy Research and Development Authority (NYSERDA) Multifamily Building Performance Program (MPP) (HTF 2010).

Although many of these programs and concepts of green building and energy efficiency in residential construction have existed since the 1970s, these practices were adopted by relatively few builders and trade contractors. This lack of familiarity by the trade contractors and builders presents a challenge for the developer of these projects when soliciting bids and gathering costing information for the work. To accurately prepare budgets for inclusion in grant applications, developers must rely on their trades to provide estimates for the work. However, if the trades do not know what the best or most cost-effective practice is for the specific measure, a high degree of variability among the bids received can result. With a range of estimates, it becomes difficult for the developer to determine an accurate estimate for the project, resulting in an increased likelihood that the project will encounter costly changes that could result in exceeding the planned budget.

As a means of managing the variability among bids from different contractors, developers aim to identify consistent, cost-effective ways for their trade partners to execute the required measures and to communicate these recommended approaches through the use of standardized language in construction documentation via model specifications. Model specifications are documents that describe the systems and components being installed in the building with details on specific requirements for the products, execution of installation, and standards to reference. Many manufacturers provide their own model specifications for the products they produce as a tool for architects, building designers, and developers to use in specifying how materials should be selected and used for a particular project.

Important Definition –
Model specifications: Documents used in the construction industry to describe and communicate details and technical requirements about the building systems and components being installed.

As building types and construction practices can vary among projects, especially projects located in different climate zones, the building specifications selected for use may also vary. Rather than developing new specifications for each new project, these model specifications can serve as templates that can be modified and adapted for reuse with project-specific information.

A common problem in the building industry is the lack of general understanding of building science best practices relating to energy efficiency, building durability, and building performance. Project design professionals do not understand the potential negative interactions and complications that can occur from specifying combinations of certain building practices and systems, especially when those specifications relate to improving the energy efficiency and performance of buildings. For example, the developer or architect may have a requirement to make the building more airtight through improving the air sealing and insulation practices. However, they may not understand the implications of those changes on the venting capabilities of combustion appliances within the building. The project teams risk unintentionally creating issues from specifying individual system and component improvements to meet their energy efficiency and building durability requirements without an understanding of how the building operates and performs from a holistic point of view.

Model specifications typically do not provide information to the user on the intended performance of the product or component as it relates to the building as a whole; instead, they simply provide details specific to the component. Creating model specifications that include more guidance on building science, durability, and system interaction considerations could be beneficial to users on both the design and implementation ends of the work spectrum. These modified specifications could help the design team to understand the possible implications of specifying certain products and building practices for the trades to execute. They also could provide additional guidance to the trades on cost-effective products and building practices and on the potential effects of not properly selecting and installing the components on other systems and the building as a whole.

The modification of model specifications to include guidance on energy efficiency measures is one approach that developers such as Mercy Housing of Denver, Colorado are using to assist their project teams. Mercy Housing is a national nonprofit organization that works to improve neighborhoods by providing services for development, preservation, management, and affordable financing for housing projects, with a goal of improving the economic status of residents, revitalizing neighborhoods, and stabilizing lives. Mercy Housing owns and operates more than 35,000 units of affordable rental housing throughout the United States.

2 Need for Energy Efficiency in Low-Income Households

Industry data indicate that low-income housing stock has a relative inefficiency when compared to other types of households. As can be seen in Table 1, non-low-income households actually averaged higher energy consumption than low-income households. However, when considering the amount of energy consumed per square foot of conditioned floor area (i.e., the energy intensity), the numbers indicate that low-income households have nearly 25% greater energy intensity. This disparity can be attributed somewhat to older and less efficient appliances and space conditioning equipment, less efficient buildings, and possibly a higher occupancy rate in low-income households.

Table 1. Impact of Energy Cost on Low-Income Multifamily Housing—Energy Intensity.

Household Type	Average Annual Weather–Adjusted Energy Consumption (Mbtu)	Energy Intensity (Average Annual Energy Consumption per Square Foot of Heated Floor Area) (Btu/ft^2)
Non-low-income	102	69
Low-income	84	90.2

Source: Eisenberg (2010).

Similarly, the energy burden is another indication of the difficulties faced by low-income households. The energy burden as seen in Table 2 is the burden placed on households due to the cost of the energy they use and is calculated by dividing the cost of the energy consumed by the total household income. Table 2 shows that the energy burden for low-income households is nearly three times that of non-low-income households.

Table 2. Impact of Energy Cost on Low-Income Multifamily Housing—Energy Burden.

Household Type	Average Annual Income (Adjusted for Inflation)	Energy Burden (Average Residential Energy Expense Divided by Average Income)
Non-low-income	$71,144	3.3
Low-income	$18,624	10

Source: U.S. Energy Information Administration (April 2008).

Compared to other types of low-income housing, small multifamily housing has by far the highest energy intensity with an average of 139 Btu/ft^2. This translates to nearly 40% higher than the energy intensity of other low-income housing types, as shown in Table 3.

Table 3. Energy Intensity of Small Multifamily Buildings.

Low-Income Household Type	Energy Intensity (Average Annual Energy Consumption per Square Foot of Heated Floor Area) (Btu/ft^2)
Single-family buildings	81
Apartments in large buildings	83
Small multifamily buildings	139

Source: Eisenberg (2010).

The data presented in Table 1 through Table 3 inclusive demonstrate a large gap in the availability of energy efficient housing options for low-income families in need of affordable, low-rise small multifamily buildings. Both federal and state agencies have recognized this need and are driving developers and building owners toward offering such options through the use of incentives and programs such as the Low Income Housing Tax Credit (LIHTC) Program.

LIHTC gives state and local LIHTC-allocating agencies the equivalent of nearly $8 billion in annual budget authority to issue tax credits for the acquisition, rehabilitation, or new construction of rental housing targeted to low-income households.

Many states are beginning to require or recommend that LIHTC projects incorporate green building practices or energy efficiency measures as part of their development plans. Rather than develop their own list of measures, a common practice for many state agencies allocating the funds is to require or recommend that the project complies with an existing or established green building or energy efficiency certification program. For example, in Colorado, the Enterprise Green Communities Criteria (EGCC) program has been adopted as the minimum requirements that LIHTC projects must meet in relation to green building and energy efficiency bills (Enterprise Community Partners 2011). The measures in the EGCC were developed as part of the Enterprise Green Communities (EGC) program to align affordable housing investment strategies with environmentally responsive building practices. The EGCC program was based on technically sound building science principles that closely align with other national green building programs, such as the U.S. Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED) program. Being the nation's most widely adopted comprehensive green affordable housing framework, the EGCC program integrates materials and methods that promote environmental quality, economic vitality, and social benefits through the design, construction, and operation of the built environment. The goals of the EGCC are to deliver significant health, economic, environmental, and building performance benefits to low-income residents so that the homes may be operated and conditioned at a level that does not forego the occupants' health or safety while still maintaining affordable energy. The EGCC program guides the project design team through a series of mandatory and elective measures in eight categories that will ensure that a whole-house integrated design approach is used in the development of the project. The EGCC program information can be found in the reference Enterprise Community Partners (2011).

The eight categories of the EGCC program are as follows:

- Integrative Design
- Location and Neighborhood Fabric
- Site Improvements
- Water Conservation
- Energy Efficiency
- Materials Beneficial to the Environment
- Healthy Living Environments
- Operations and Maintenance

The U.S. Department of Housing and Urban Development (HUD) has been encouraging the incorporation of energy efficiency measures in affordable multifamily rehabilitation projects by making additional funds available to applicants if their projects meet certain green building and energy efficiency requirements outlined in the various state funding programs. For example, in 2009, the HUD Office of Affordable Housing Preservation (OAHP) developed the Green Retrofit Program (GRP) for Multifamily Housing. The GRP created green-collar jobs while improving property operations of existing multifamily assisted housing stock. The program offered grants and loans up to $15,000 per residential unit to reduce energy costs and water use, to improve indoor environmental quality, and to provide other environmental benefits through green and energy retrofit investments in existing properties.

At the state level, many funding sources also are encouraging or requiring energy efficiency and green features in affordable housing rehabilitation and new construction projects. For example, the Housing Trust Fund (HTF) in New York State (which uses HUD HOME Investment Partnership Program funds) limits the amount of funding an individual project can receive up to $2 million. However, if the project demonstrates design intent and provides proof of compliance with specific green building or energy efficiency initiatives outlined by the HTF, the project could be eligible for up to $2.4 million of funding.

Affordable housing preservation is a critical strategy to addressing the gap in available affordable housing properties. According to Mercy Housing, “thousands of multifamily rental properties are at risk of being lost from the pool of available affordable housing because of expiring public funding. By buying, refinancing, and upgrading those facilities, Mercy Housing can supply more affordable housing opportunities for the long term without engaging in a great deal of new construction.” (L1SEA 2009)

3 Partnership With Mercy Housing

Mercy Housing partnered with IBACOS to begin addressing the lack of centralized design knowledge within its organization. Together, Mercy Housing and IBACOS have undertaken the task of developing and revising sample model specifications that can be used by Mercy Housing's designers, architects, and project teams to understand the risks, interactions, and opportunities associated with various energy related measures and strategies for comprehensive retrofits and new developments.

Mercy Housing experienced an increasing number of requests from its design teams to provide greater guidance and specificity to the mostly generic content in their existing specifications related to energy efficiency, building durability, space conditioning equipment, and renewable energy technology. Mercy Housing partnered with IBACOS to review the energy efficiency and building durability related model specification documents that Mercy Housing currently uses for its new construction and retrofit projects in multiple climate zones. IBACOS added content to the specifications regarding the system interactions, risks, energy efficiency, durability, and health and safety implications of the individual specification in relation to the building systems and project as a whole.

As Measure Guidelines are developed that address improvements to energy efficiency in the various building system end uses, these specification documents can be used to supplement the information contained within the Measure Guidelines. The specification documents also can be used as a resource that offers specific guidance on products, building practices, and standards that meet the intended performance of the components and systems contained within the Measure Guidelines.

Important Definition –
Measure Guidelines: Documents developed by the U.S. Department of Energy Building America program teams to provide guidance on the implementation of measures of energy efficiency, building durability, and whole-house performance.

4 Model Specifications

Model specifications are documents used throughout the construction industry as a means of describing and communicating information about the building systems and components being installed. They include specific details and technical requirements for installing and constructing the components. Model specifications following the Construction Specification Institute (CSI) MasterFormat system of numbering (CSI 2011) are broken into groups, subgroups, and divisions, based on the major systems of the building that the component will address. Table 4 shows examples of the major subgroups and divisions.

Table 4. Example of CSI MasterFormat Subgroup and Division Breakdown.

Facility Construction Subgroup	
Division 2	Existing Conditions
Division 3	Concrete
Division 4	Masonry
Division 5	Metals
Division 6	Wood, Plastics, and Composites
Division 7	Thermal and Moisture Protection
Division 8	Openings
Division 9	Finishes
Division 10	Specialties
Division 11	Equipment
Division 12	Furnishings
Division 13	Special Construction
Division 14	Conveying Equipment

(Source: CSI 2011)

Within each division, the building systems are further divided based on individual components, as shown in Table 5.

Table 5. Example of Division Breakdown Using CSI MasterFormat Numbering System.

07 00 00 THERMAL AND MOISTURE PROTECTION
07 01 00 Operation and Maintenance of Thermal and Moisture Protection
07 01 10 Maintenance of Dampproofing and Waterproofing
07 01 10.81 Waterproofing Replacement
07 01 20 Maintenance of Thermal Protection
07 01 30 Maintenance of Steep Slope Roofing
07 01 40 Maintenance of Roofing and Siding Panels
07 01 50 Maintenance of Membrane Roofing
07 01 50.13 Roof Moisture Survey
07 01 50.16 Roof Maintenance Program
07 01 50.19 Preparation for Re-Roofing
07 01 50.23 Roof Removal
07 01 50.61 Roof Re-Coating
07 01 50.81 Roof Replacement
07 01 50.91 Roofing Restoration
07 01 60 Maintenance of Flashing and Sheet Metal
07 01 60.71 Flashing and Sheet Metal Rehabilitation
07 01 60.91 Flashing and Sheet Metal Restoration
07 01 60.92 Flashing and Sheet Metal Preservation
07 01 70 Operation and Maintenance of Roof Specialties and Accessories
07 01 80 Maintenance of Fire and Smoke Protection
07 01 90 Maintenance of Joint Protection

(Source: CSI 2011)

Individual model specifications are broken down into three sections that address the following: (1) general comments, (2) specific technical requirements for products and components, and (3) measures for the execution of installation.

The General section lists other model specifications that are related to the installation of this particular component; outlines what information and components are covered in this particular specification; gives a description of the system or component by providing a list of reference standards with which the component must comply; and overviews the requirements for material storage and handling.

In the Products section, the building designers and architects give recommendations for specific manufacturers and products that meet the requirements of the selected components. This section also outlines the specific characteristics of the components. For example, the Products section of a model specification for exterior doors may include information on acceptable manufacturers; door type; frame type; door face thickness and material type; door edge construction; types of core, gasketing, weatherstripping, hinges, and strikes; etc.

Finally, the section on Execution focuses on the process of installing the component. Model specifications are not intended to be step-by-step installation guidelines for materials; instead, their intent is to point out the site conditions that should be inspected and verified prior to installation of the component, to establish general guidelines for the quality of installation, to identify measures of quality assurance that should be checked, and if applicable, to outline recommendations for ongoing maintenance of the product.

5 Revisions to Specifications

By adding more clarity and guidance to these model specifications, the goal of the revisions is to create a greater level of understanding of the risks and implications associated with the measures as well as to improve the consistency in execution of energy efficiency retrofit measures across the multiple regions where a developer may work.

Model specifications are intended to be revised and modified as necessary, depending on the particular needs and conditions of a project. The sidebar notes and comments added to these model specifications are solely for the use of the building design team and should be removed from the specification documents prior to providing those documents to the general contractor and trades as part of the construction documentation.

To indicate the intent and capacity of the model specifications, an introductory note was added to each specification to explain that the information contained within the document has its limitations. Although the information that has been added to the specification provides guidance to the design team, general contractor, and trades, ultimately the building designer has the responsibility to determine which materials and components will be selected for use in construction of the project. This decision should be made after considering what other requirements exist, including local or regional codes, climate zone conditions, and other site conditions. Figure 1 provides an example of an introductory note that states that the building designer or project architect should fully understand the building science principles relating to the specific components being discussed in the specification—including what interaction those components may have on the performance of other systems in the house—before selecting the particular specification as appropriate for the project.

SECTION 13 65 00 PHOTOVOLTAIC (PV) POWER SYSTEMS

Note: The application of this component specification assumes that architect and building designer are familiar with the building science concepts relating to building system component interactions (e.g., moisture, condensation, and thermal profiles through building assemblies, etc) and the implications associated with specifying particular materials for use. Not all components contained in these specifications are applicable for use in all building systems. It is the responsibility of the building designer and/or architect to select a component that is suitable for each particular building design. This specification is not intended to supersede local, state, or federal codes. This specification assumes that the installer possess a good working knowledge of the applicable codes and regulations, safety practices, and methods necessary for proper installation. It also assumes that the installer understands the fundamentals of residential construction that affects the installation of a complete grid tied photovoltaic (PV) power systems, including all support structures necessary to mount the systems to the standard shingle roof. System shall be rated at a minimum KW AC PTC as required per site.

Figure 1. Example of an introductory note for a revised model specification, which explains the building designers' responsibilities

As shown in Figure 2, for each of the revised model specifications, IBACOS added a section to explain the intended performance of the particular component. Information is included about the expectations and limitations of performance, as well as why the component or system is being installed. This provides the user of the document with a more macroscopic view of what the component contributes to the overall performance of the building and how it may interact and impact other components or systems within the building. By providing this information, it is expected that the user will have a better understanding of the potential implications of improper installation of the component and the possible impact on subsequent trades or systems in the building.

1.10. INTENDED PERFORMANCE

A. Regardless of the level of energy efficiency a home can achieve through energy conservation measures, the home will still require the use of energy to operate many of the building's mechanical systems, lighting, and appliances. Residential scale solar PV systems are designed to use sunlight to generate electricity at the location where the electricity is needed. In certain municipalities, residences that have a grid-tied electrical system are permitted to sell their excess energy to the utility grid through a policy known as "net metering," whereby the owner of the PV system receives compensation from the utility for its net outflow of power. *[**Note to Building Designer/Architect** - Grid-interactive PV systems are covered by specific provisions in the National Electric Code, which also mandates certain requirements for grid-interactive inverters.]* A grid-tied PV system is typically designed to generate electricity to partially or completely offset the electricity required from the utility; however, it is not intended to provide the electricity required by the home during all times of day or all times of year. The system will not generate electricity when sunlight is not present, and the home therefore will need to use electricity from the utility supplier.

Figure 2. Revised text explaining the intended performance of a component on a building system.

Although these specifications assume that the design team is familiar with and understands basic building science principles, IBACOS believed that a greater understanding of the concepts of home performance would enable the design teams to make more informed decisions regarding the materials, components, and standards those teams specify for use on their projects. With this in mind, IBACOS decided to include notes and comments in these documents to further explain principles of building science, durability, moisture management, and whole house performance that the designer should consider when determining whether the specification is appropriate for a particular project. The notes and comments were included as text in sidebars. These sidebar comments were not intended to remain in the final version of the specification that would be used in construction and bid documentation; rather, the comments are included as sidebars to allow the individuals developing the specification to take note of the information and determine if it is pertinent to their particular project. After the information within the sidebar is appropriately addressed and considered, then the author of the specification can remove the sidebar comments and prepare the document for use with the other construction documentation.

As shown in Figure 2 and Figure 3, throughout the body of the specification, IBACOS included recommendations for performance levels, industry standards, and specific products that would enable the user of the document to achieve the performance levels that had been required and outlined for the project. Red italics indicate general commentary about the component properties and related building systems to consider when determining which component to specify.

1. PART 1 GENERAL
   1.1 RELATED DOCUMENTS
      A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 – General Requirements, and the Drawings are collectively applicable to this Section.
      B. 07 30 00 Steep Slope Rooting
      C. 26 00 00 Electrical
   1.2 SECTION INCLUDES
      A. PV array
         1. Modules
         2. Inverter
         3. Power monitoring and data acquisition
         4. All wiring and conduits
         5. All module racking components and attachments to
         6. Safety features to meet NEC Standards
   1.3 COMPONENT DESCRIPTION
      A. Standards: Performance of the component is designed to meet or exceed the Reference Standards and Resources specified:
         1. American Society for Testing and Materials (ASTM)
         2. National Electric Code (NEC)
         3. American Society of Civil Engineers Standard for Minimum Design Loads for Buildings and Other Structures (ASCE 7)
      B. PV Array
         1. Unless otherwise specified or dictated by site condition, all PV arrays should be oriented to achieve maximum kWh production. *[Note to the Building Designer/Architect - The performance and efficiency of the PV system is greatly affected by the orientation of the system. Each system must be evaluated for proper orientation. PVWatts v.2 A Performance Calculator for Grid-Connected PV Systems is available for analysis of system configuration. http://rredc.nrel.gov/solar/calculators/PVWATTS/version2/. Researchers at the National Renewable Energy Laboratory developed PVWatts to permit non-experts to quickly obtain performance estimates for grid-connected PV systems. Version 2 can be run for locations within the 48 contiguous states, Alaska, and Hawaii.]*
         2. PV arrays should be located to prevent shading from trees, poles, or other structures between the hours of 9:00 a.m. and 3:00 p.m. *[Note to the Building Designer/Architect - Shading will have an exponential effect on PV performance. Small amounts of shading can greatly reduce the energy production of the system.]*
         3. PV arrays must be securely installed to the facility roof structure as dictated by site conditions to accommodate for wind loads.
         4. PV array and supporting structure must comply with wind uplift requirement wind loads per the American Society of Civil Engineers Standard for Minimum Design Loads 5 and Buildings and Other Structures (ASCE 7).

Figure 3. Example of general commentary (red italic type) and revisions to the body of a model specification.

Guidance for the execution of the work, which incorporates recommended inspection, installation, and verification practices, is included in each revised specification. However, it is important to note that the specifications are not intended to provide step-by-step installation instructions or details for contractors to follow for the particular building components. These types of details should be included with the construction drawings or are part of the manufacturer's installation procedures.

Although including additional design and building science considerations in model specifications will enhance the usefulness of these documents and further educate the end user, no model specification can provide all of the possible or necessary information for a particular project. Each project will have local or state code requirements with which it must comply. If local or state codes

differ from the recommendations in the specification documents modified by IBACOS, the code requirements supersede the requirements in the specifications. Modifications to the model specifications should be reviewed by the building designer and adapted for use in the specific climate in which they are being used, according to the building assembly type, targeted performance levels, and local or state code requirements.

One note of caution must be considered when using specifications as part of any construction documentation. Although model specifications provide the general contractor and trades with very specific guidance on the materials and components to use for the project, those specifications also can be used by the contractor, trades, or even occupants after completion of the project to hold the building designer liable for construction defects that arise. If an improper material or component is specified for a project, the specifications can be used to identify the designer as the responsible party. Due to the potential liability associated with developing the requirements and outlining specific materials and components, some developers, including Mercy Housing, have begun to seek alternative approaches for communicating project requirements while still giving their contractor and trades the final responsibility of selecting materials and practices to use in meeting those requirements.

6 Specifications as Part of Construction Documentation

At the early stages of a new project that is pursuing financial assistance through state or federal grants and funds, the project team will work with a Home Energy Rating System (HERS) rater to complete a Physical Needs Assessment (PNA). A PNA identifies physical improvements, including assumed maintenance within the next five years, which must be completed to bring the development (including dwelling and non-dwelling structures and equipment and the site) up to a level at least equal to the modernization and energy conservation standards and to comply with program requirements.

Additionally, during this early time in a new project, the team will review the requirements of the Qualified Allocation Plan (QAP) to determine the components that will be required in its application for funding and the relative weight given to each of the components included in the Division of Housing and Community Renewal (2011). The QAP establishes a state's selection criteria for how its available tax credits will be awarded. Federal code mandates the criteria a state must include in the QAP against which to evaluate applications (Division of Housing and Community Renewal 2011). Until recently, a list of eight criteria focused on characteristics of the housing, project, and tenant needs. However, following the passage of the 2008 Housing and Economic Recovery Act, criteria for energy efficiency and the historic character of a project were added to the requirements for states' QAPs.

The project team will review the PNA as well as any specific requirements of the QAP. Then, using an integrated design approach, the team will define the building practices, systems, and components to be included in the rehabilitation of the property. HERS raters should be key participants in this process because they can offer expert advice on building performance from a whole-house approach, whereas builders and architects typically look at individual systems and components. If a HERS rater is not intimately involved in the design process, the concepts of building science, energy efficiency, and whole-house integrated design practices often are not clearly understood by developers, architects, builders, and trade contractors. This lack of understanding can affect the interactions among the various system components and ultimately can compromise the performance of the building as a whole.

In many cases, the property management and redevelopment companies have operations in multiple municipalities and even multiple states, further complicating the ability to standardize building designs and system specifications that will meet the requirements of the various regional jurisdictions and sources of funding.

The model specifications, which use the CSI MasterFormat numbering system, are being developed for use as a tool by building designers and architects when creating construction documentation. Appendix A shows an example of a portion of a typical package of construction documentation (e.g., site work specifications; mechanical, electrical, and plumbing specifications; architectural specifications; bid instructions; and wall section details) provided by developers or builders to their trade contractors. These examples highlight the level of information that is commonly passed along to contractors for the purpose of executing the details of a project. As can be seen in the sample bid instructions document, which contains individual scopes of work for the trades to use in development of their bids, the scopes provide generic line items outlining what contractors should be accounting for in their bids. The instructions include references to both "plans and specifications" for additional information.

The contractors use plan sets to complete takeoffs and to construct the building. The purpose of the specifications is to complement the construction drawings in a bid package for the general contractor. The specifications also outline the best practice recommendations for selecting the appropriate components and materials to execute the building assembly details specified on the construction drawings and documentation. The general contractor uses the specifications to have a better understanding of the individual components for which they will be responsible and, in turn, to more accurately develop their bid proposals. The specifications are not intended to provide guidance to the design team (i.e., architects, builders, building designers) on which retrofit building systems or strategies should be used in a specific climate; instead, the specifications indicate the parts and pieces the general contractor should use to achieve the stated level of performance for the building systems included in the construction documentation.

7 Common Affordable Multifamily Building Energy Efficiency Measures

Mercy Housing has ongoing projects in each of the major U.S. DOE climate zones with multiple building types present throughout each, and it needs to develop climate-specific specifications for each of its regional offices. Due to the fact that energy efficient building systems and strategies as well as durability and moisture management details can vary among the different climate zones and building types, developing specifications that would be applicable to all types of projects across all climate zones would be beyond the current scope of this project.

IBACOS and Mercy Housing selected the Building America cold climate region and three-story or fewer wood-framed construction as the building type for which sample model specifications would be developed. These specifications could be used as templates for the future development of additional specifications. Mercy Housing identified typical energy efficiency measures that are being specified as part of its compliance with the Enterprise Green Communities Criteria (EGCC) program, which is further discussed in the Federal and State Energy Efficiency Financing Programs section in this report. IBACOS completed revisions to the 14 specifications shown in Table 6. The revised specifications can be found in Appendix B through Appendix O. These specifications for energy efficiency measures were identified by both IBACOS and Mercy Housing as areas where Mercy Housing lacked good recommendations and documentation to provide to its project teams. Table 7 lists other specifications that could be developed.

Table 6. List of Revised Specifications.

CSI Specification Division	Specification
Division 07 – Thermal Protection	07 21 13 Board Insulation 07 21 16 Batt and Blanket Insulation 07 21 19 Foamed-in-Place Insulation 07 21 23 Loose-Fill Insulation 07 21 26 Blown Insulation – Damp 07 21 26 Blown Insulation – Dry 07 21 29 Sprayed Insulation 07 25 00 Weather Barriers
Division 08 – Openings	08 16 13 Exterior Fiberglass Doors 08 53 13 Vinyl Windows
Division 23 – HVAC	23 30 00 HVAC Air Distribution 23 54 16.13 Gas-Fired Furnaces 23 63 13 Air-Cooled Refrigerant Condensers
Division 48 – Electrical Power Generation	48 14 13 Solar Energy Collectors

Table 7. Other Possible Specifications for Future Development.

CSI Specification Divisions	Specification
Division 06 – Wood Plastics and Composites	06 10 00 Rough Carpentry
Division 07 – Thermal and Moisture Protection	07 10 00 Dampproofing and Waterproofing 07 27 00 Air Barriers 07 31 13 Asphalt Shingles 07 40 00 Roofing and Siding Panels
Division 11 – Equipment	11 30 00 Residential Equipment
Division 22 – Plumbing	22 30 00 Plumbing Equipment 22 41 00 Residential Plumbing Fixtures
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	23 01 00 Operation and Maintenance of HVAC Systems 23 06 00 Schedules for HVAC 23 07 00 HVAC Insulation 23 08 00 Commissioning of HVAC 23 30 00 HVAC Air Distribution
Division 26 – Electrical	26 50 00 Lighting

The specifications were developed based on a common building construction type that Mercy Housing encounters on many of its projects. Figure 4 shows a typical wall section for Mercy Housing's low-rise (fewer than three stories) multifamily buildings, which include a crawlspace or basement; a wood-framed floor system; 2x4 or 2x6 wood-framed insulated walls fully covered with exterior sheathing; housewrap; siding; and a wood-framed (stick or truss) roof system with asphalt composition shingles. Each unit has an individual space conditioning system and water heater. IBACOS used this representative building construction type in the development of these model specifications. Many different types of buildings and building practices exist, resulting in the need for model specifications specific to those particular applications.

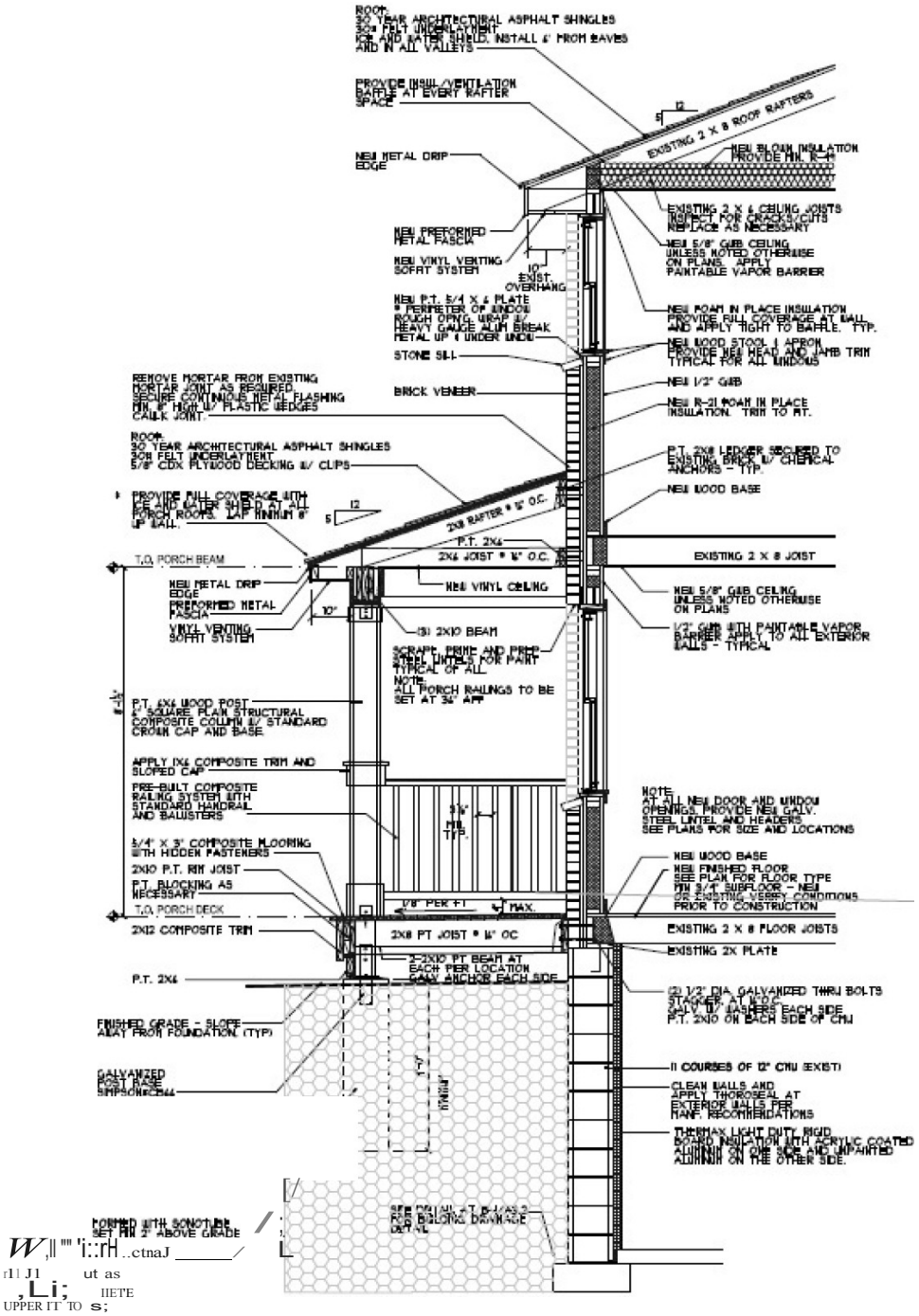

Figure 4. Exterior wall section from a representative multifamily building used in revising the specification documents.

8 Conclusion

With the demand for and cost of energy ever increasing in the United States, it has become even more critical to find cost-effective approaches to ensuring that affordable housing remains affordable for low-income families to live in and operate. Federal and state agencies have recognized the need for the reduction in energy usage to begin playing a larger role in multifamily affordable retrofit projects to ensure their affordability. Ever more are they incorporating requirements in their low-income housing funding programs for improving the energy efficiency of buildings.

As these requirements have come along for developers of affordable housing projects, so has the need for guidance and understanding within developers' project teams on how to meet and comply with these program requirements. Mercy Housing, for example, received an increasing number of requests by architects and building designers for standardized guidance on specifying the building components that will meet the intended performance of a particular energy efficiency measure. Specifications, modeled after CSI MasterFormat, provide the trade contractors and builders with requirements and recommendations on specific building materials, components, and industry practices that comply with the expectations and intent of the requirements within the various funding programs associated with a project. These specification documents provide more clarity and guidance for the general contractor and trades. The goal of the specifications is to create a greater level of consistency in execution of energy efficiency retrofit measures across the multiple regions where a developer may work.

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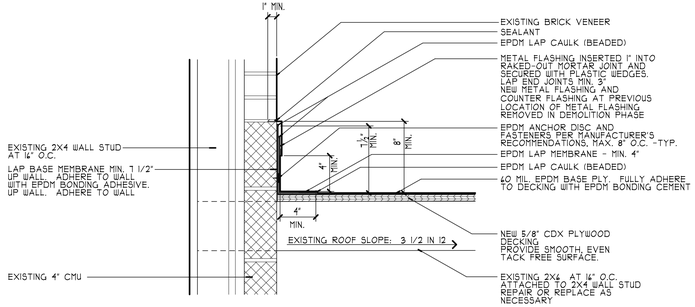
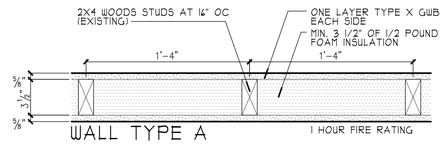
Appendix A: Example of Part of a Typical Construction Documentation Package



FLAT ROOF DETAIL AT WALL (B-1 / A3.2)
SCALE : 1/2" = 1'-0"



RATED WALL CONSTRUCTION (C-1 / A3.2)
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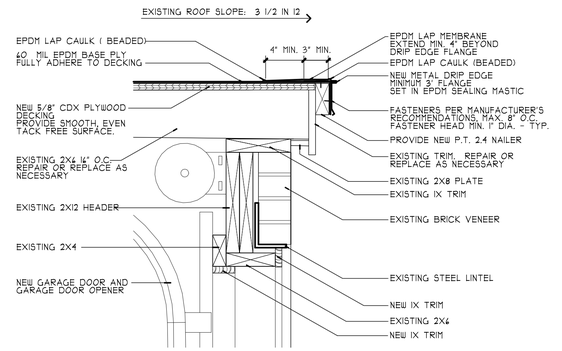

FLAT ROOF DETAIL AT EDGE (B-1 / A3.2)
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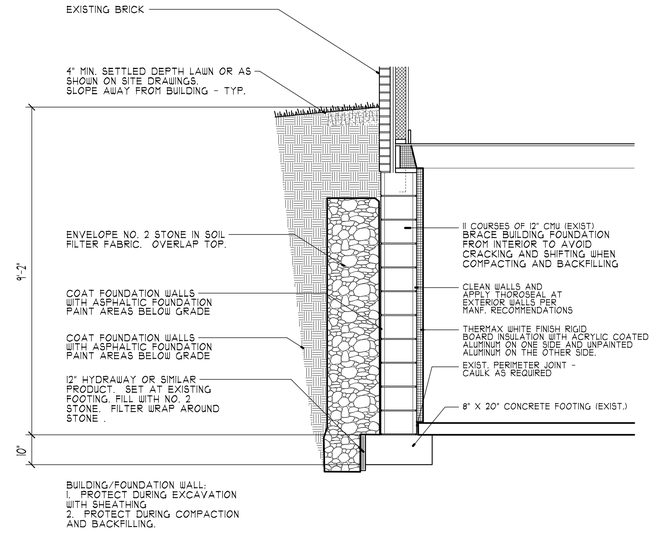
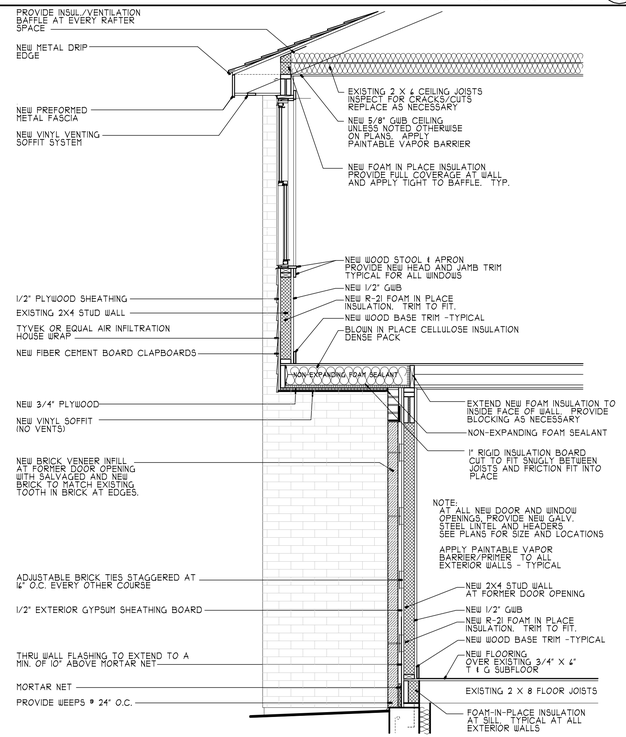
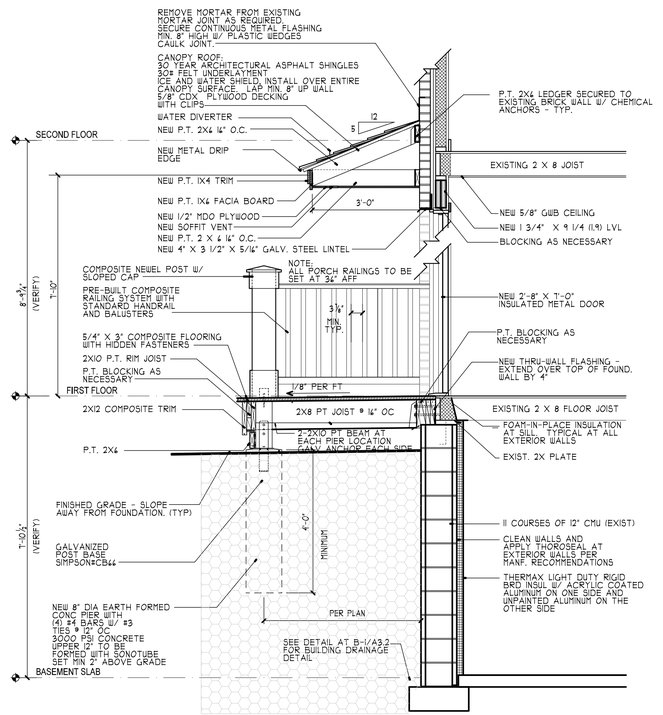


WALL SECTION (B-1 / A3.2)
SCALE : 1/2" = 1'-0"

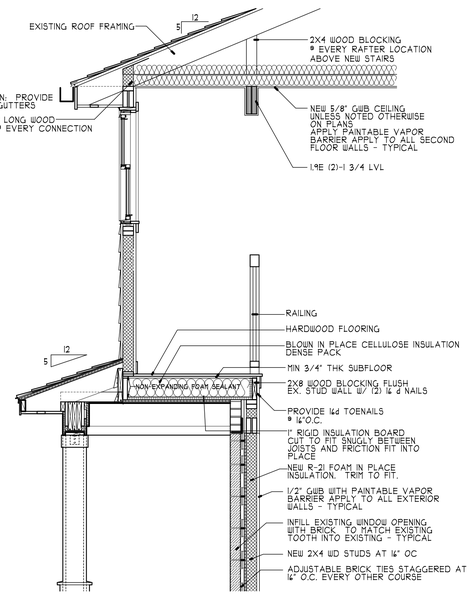
NOT USED (B-1 / A3.2)
SCALE : 1/2" = 1'-0"



WALL SECTION (A-1 / A3.2)
SCALE : 1/2" = 1'-0"



WALL SECTION (A-2 / A3.2)
SCALE : 1/2" = 1'-0"



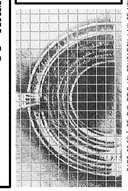
WALL SECTION (A-3 / A3.2)
SCALE : 1/2" = 1'-0"

REV. No :	DATE :	DRAWN BY :	DESCRIPTION :

JOB NO:	09059
DATE:	18 FEB 2011
DRAWN BY:	MCM
SCALE:	AS NOTED

PROPOSED ALTERATIONS AND RENOVATIONS FOR
HAMILTON HOMES PHASE III
96 HAMILTON STREET OSWEGO, NEW YORK

HOLMES ▪ KING ▪ KALLQUIST
& Associates, Architects—LLP.
575 North Salina Street ▪ Syracuse, NY 13208
Fx (315) 476-5420 ▪ Ph (315) 476-8371
www.hkkarchitects.com



WALL SECTIONS

A3.2

Housing Visions Construction
Oswego Hamilton Homes -3 Project
Bid Instruction Sheet

Scope of Work: Rough Carpentry

Provide a "Labor and Fastener Only" price "Per Building" a square foot price is not a substitute for a per building price .
to completely remodel the existing buildings as per the plans, specifications and the following:

Install any new basement support posts and beams.(If Applicable)

Include all jacking and squaring for level and plumb finish.

All subflooring to be repaired with same dimension material then entire deck to be covered with 1/2 plywood fully glued and screwed down to floor joists.

2x6 Collar Ties to be installed to rafters per spec.

All non-usable walls to be removed by contractor. Maximum of 16 feet of framing to be removed at a time. Bracing and collar ties will be used for stablization of exterior walls and rafters.

Reframe and/or resheath any flooring systems, exterior walls and roofs as per plans and specifications.

Frame and/or reframe all interior walls and stairways as per the plans and specifications..

Frame and/or reframe any roof overhangs and sub fascias as per the plans and specifications.
All windows and exterior doors installed.
Infill all exterior walls with same dimensional material. Where siding is to be applied sheath over existing with 7/16 OSB.

ALL PORCHES TO BE BID SEPARATELY AT A PER BUILDING PRICE
All porch footers to be installed by HVCC
Contractor Responsibility:
All porch and deck floor **framing** installed .
All porch roofs are to be framed, sheathed, and supported with temporary supports.
All necessary bracing to complete the above work.
Install 1/2" plywood temporary over deck framing until others install deck.
Temporary exterior stairs to be installed to access all parts of the building.

Also include an hourly, per man, rate for any additional work that maybe required.

Notes:

Any lockable storage required shall be provided by the framing contractor.

Rough Framing contractor shall supply all fasteners necessary to complete the above work.

All other framing materials shall be provided by HVCC

Rough Framing contractor shall supply all necessary safety equipment, scaffolding, tools etc

Rough Framing contractor shall supply all hoists, lifts and cranes necessary to complete the above work.

All OSHA safety requirements shall be followed.

Daily clean up and remove all debris from this scope of work, including all packaging, to HVCC supplied dumpster.

Fully implement HVCC Recycling and Diversion Policy (included in project Manual) as pertains to your scope of work.

Separate dumpsters will be supplied for clean wood and C&D. They will be labled.

SECTION 06100 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work included: The work under this Section of specifications includes all labor, materials, equipment and services necessary to complete the rough carpentry work as shown or called for on the drawings, including but not limited to:

1. Carpentry repairs: provide blocking as required for a complete repair of interior ceiling areas and interior soffit areas. Provide all miscellaneous assemblies and fasteners for securing wood blocking to the structure.

a. Ceiling and Floor repairs or infill areas.
b. Miscellaneous exterior wood soffit repairs as necessary.
c. Wood blocking at door frames.
d. Wood blocking at window systems.
e. Wood blocking at roof edges and penetrations.
f. Miscellaneous nailers, blocking, furring, and sleepers.
g. Miscellaneous rough hardware and fasteners.

2. Furnish and install:

a. Wood blocking back-up for fastening finish materials and hand bars.
b. Miscellaneous blocking for anchoring.
c. Rough hardware.

B. Related work: Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary General Conditions and Sections in Division 1 of these Specifications, including work specified in other sections as follows:

1. Miscellaneous Carpentry - Section 06105.
2. Finish Carpentry - Section 06200.

1.2 SUBMITTALS

A. Submit for approval product data.

1.3 QUALITY ASSURANCE

A. Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three

years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Lumber, finished 4 sides, 15% maximum moisture content:

1. Light framing: Construction grade Douglas fir or southern pine, appearance grade where exposed.
2. Boards: Construction grade.

B. Wood for nailers, blocking, furring and sleepers: Construction grade, finished 4 sides, 15% maximum moisture content. Pressure preservative treat items in contact with roofing, flashing, waterproofing, masonry, concrete or the ground.

C. Plywood, APA rated for use and exposure:

1. Sheathing: APA sheathing, C-D plugged, Exterior.
2. Backing panels: APA C-D plugged interior with exterior glue, fire-retardant treated, 3/4" thick, urea-formaldehyde free or seal all surface planes prior to installation.

D. Building paper: Asphalt saturated felt, non-perforated, ASTM D 226, Type 1.

E. Wood treatment:

1. Preservative treatment: Pressure-treated with waterborne preservatives, to comply with AWPB LP-2 or LP-22, as applicable. Kiln dry to 15% max. moisture content. Treat wood exposed to deterioration by moisture, such as items in contact with roofing, flashing, waterproofing, masonry, concrete, or the ground. Treat wood subject to insect attack.
2. Fire-retardant treatment: Pressure impregnated, to comply with ASTM E 84, Class A, and with AWPA C20 and C27; provide where indicated and where required by code. Plywood shall be identified with FR's label of U.L.

F. Rough hardware: Bolts, nails, clips, as required for a complete quality installation.

G. Expansion fasteners at concrete: Select expansion bolts to achieve solid anchorage in concrete without splitting, spalling, or cracking. Use chemical bolts where sufficient anchorage cannot be achieved by expansion bolts.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Provide nailers, blocking and grounds where required. Set work plumb, level and accurately cut, and rigidly secured in place.

B. Install materials and systems in accordance with manufacturer's instructions and approved submittals. Install materials and systems in proper relation with adjacent construction. Coordinate with work of other sections.

C. Comply with manufacturer's requirements for cutting, handling, fastening and working treated materials.

D. Restore damaged components. Protect work from damage.

END OF SECTION 06100

Appendix B: Section 07 21 13 Thermal Insulation Board Insulation

Note: The application of this component specification assumes that the architect and building designer are familiar with the building science concepts relating to building system component interactions (e.g., moisture, condensation, and thermal profiles through building assemblies) and the implications associated with specifying particular materials for use. Not all components contained in these specifications are applicable for use in all building systems. It is the responsibility of the building designer and/or architect to select a component that is suitable for each particular building design. This specification is not intended to supersede local, state, or federal codes. This specification assumes that the installer possesses a good working knowledge of the applicable codes and regulations, safety practices, and methods necessary for proper installation. It also assumes that the installer understands the fundamentals of residential construction that affect the installation of insulation materials.

1. PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 – General Requirements, and the Drawings are collectively applicable to this Section.
B. Section 03 30 00: Cast-in-Place Concrete
C. Section 06 10 00: Rough Carpentry
D. Section 06 17 53: Shop Fabricated Wood Trusses
E. Section 07 21 29: Sprayed Insulation
F. Section 07 24 00: Exterior Insulation and Finishing System
G. Section 07 26 13: Above-Grade Vapor Retarders
H. Section 07 27 00: Air Barriers
I. Section 07 46 00: Siding

1.2 SECTION INCLUDES

A. Rigid board exterior insulating sheathings and structural insulating sheathings for use on exterior walls above grade including:
1. Extruded polystyrene
2. Expanded polystyrene
3. Polyisocyanurate

1.3 COMPONENT DESCRIPTION

*[**Note to the Building Designer/Architect –** Rigid cellular board insulation contains properties that make it flammable and therefore require additional considerations as to the use of it as a component in fire-rated building assemblies. The building designer and architect should be familiar with applicable sections of the International Residential Code (IRC) and International Building Code (IBC) on the use of foam plastic insulations and should ensure that the insulation meets the surface burning, flame spread, and smoke development requirements established by the applicable ASTM standards.]*

A. Standards: Performance of the component is designed to meet or exceed the Reference Standards and Resources specified:
1. American Society for Testing and Materials (ASTM)
2. Federal Specifications (Fed. Spec.)

3. The Society of the Plastics Industry, Inc. (SPI)
4. Underwriters' Laboratories, Inc. (UL)
5. Extruded Polystyrene Foam Association (XPSA)
6. Expanded Polystyrene Molders Association (EPS Molders Association)
7. Polyisocyanurate Insulation Manufacturers Association (PIMA)
8. Board Insulation
   a. ASTM C 578-05 – Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
   b. ASTM C 591-01 – Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
   c. ASTM C 1289-05 – Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2005.
   d. UL 723: Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

A. Submit under the provisions of Section 013300 – Submittal Procedures.

B. Submit the manufacturer's certificate under provisions of Section 014000 – Quality Requirements that products meet or exceed specified requirements.

C. Submit all requests for substitutions under provisions of Section 012500 – Substitution Procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with the manufacturer's product data for handling and storage.

B. Delivery of materials to the site shall be coordinated with the designated construction schedule to minimize the amount of time the materials are stored on site prior to installation. Materials shall not be delivered more than two days prior to being installed.

C. Materials being stored on site shall be protected from exposure to the natural elements. Any material being stored outside of the building enclosure shall be placed on blocking to keep it elevated from sitting in direct contact with the ground and covered with a waterproof, breathable covering such as a canvas tarpaulin to prevent exposure to moisture.

D. Materials that have been damaged upon receipt at the site or exposed to moisture shall be brought to the attention of the site supervisor, removed from the site, and replaced with suitable materials.

E. On-site handling of insulation shall be conducted in compliance with the manufacturer's recommended procedures in order to prevent breaking, crushing of square edges, or damage to the surface of the insulation.

1.6 QUALITY ASSURANCE

A. Retain ASTM test method below for each product in Part 2. Provide insulation and related materials with the fire-test-response characteristics required by building codes and regulations, as determined by testing identical products per ASTM E 84 for surface-burning characteristics and other methods indicated with product, by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
   1. Surface burning characteristics: ASTM E 84.
   2. Fire-resistance ratings: ASTM E 119.
   3. Combustion characteristics: ASTM E 136.

1.7 QUALITY CONTROL

A. Provide certification that insulation has been installed per the requirements of this section and the plan and code listing value. Certification shall be signed by the principal of the insulation Subcontractor and the General Contractor.

1.8 WARRANTY

A. Provide the manufacturer's standard commercial warranty for a period of at least 10 years from the date of manufacture printed on the product. The manufacturer guarantees the actual thermal resistance of the insulation will not vary by more than 10% from its published aged R-value.

1.9 INTENDED PERFORMANCE

A. Building insulation is a critical component in controlling heat flow out of a building when temperature conditions are warmer inside than outside, and controlling heat flow into a building when temperature conditions are warmer outside than inside. *[**Note to the Building Designer/Architect –** In existing houses the addition of insulating sheathing to exterior wall and band joists will affect the drying potential of the assembly. Prior to the application of insulation, wood and masonry materials could dry easily to the outside because there is no insulation impeding the movement of heat flow. The new drying potential of the wall assembly must be considered so that moisture does not become trapped, leading to assembly component deterioration. This means that all moisture and bulk water penetration mechanisms into the assembly must be successfully managed (with the use of flashing, vapor retarders, capillary breaks, etc.) so that they do not enter the assembly.]* Several important benefits are associated with adequate levels of correctly installed building insulation: energy is saved, and the cost of operating a house is reduced; the space conditioning system operates more efficiently and effectively, and occupant thermal comfort is increased because interior temperatures are more consistently near desired levels; and enclosure surface temperatures are controlled, reducing the risk of cold-weather condensation occurring on building materials and within building cavities. Furthermore, insulation materials such as rigid cellular foam sheathings, with all board joints taped and sealed, can lead to improved building air tightness and reduced uncontrolled envelope leakage and can act as a component of a vapor retarding strategy within a building assembly. *[**Note to the Building Designer/Architect –** The water vapor transmission characteristics of each type of board insulation must be considered in assembly designs. For instance, extruded polystyrene insulating sheathing can act as a class I, II, or III vapor retarder, depending on insulation thickness and its exterior facing material. Insulating sheathing with an exterior film/facing material has very low water vapor transmission characteristics.] [**Note to the Building Designer/Architect** – Vapor retarders are a critical component of moisture control within building assemblies. Specification and placement of them within the building assembly will vary, based on regional and climatic conditions. Heat flows from warm to cool areas, and, in general, the vapor retarder should be placed on the predominantly warm side of the assembly to prevent moisture from migrating, with the heat flow, to the cold side of the assembly where it could reach its dew point and condense.]* Properly integrated with exterior wall penetrations, the rigid foam sheathing can also act as the primary drainage plane to shed bulk water away from the building. In certain applications, particular rigid foam sheathing products may be used as a structural sheathing and a component of a braced wall panel. [***Note to the Building Designer/Architect –** Only DOW Structural Insulated Sheathing has been tested and can be recommended for this type of application. Other rigid foam sheathing products are not intended for use to provide lateral or transverse load support.]*

2. PART 2 PRODUCTS

2.1 Rigid Cellular Board MATERIALS for NEW and Existing Housing

A. Extruded Polystyrene Insulating Sheathing

1. Manufacturers:
   a. Dow Chemical Company; STYROFOAM Brand Residential Sheathing (extruded polystyrene). www.dow.com
   b. Owens Corning Corporation; PROPINK insulating sheathing (extruded polystyrene). www.owenscorning.com
   c. Pactiv Corporation; Green Guard insulating sheathing (extruded polystyrene). http://greenguard.pactiv.com
   d. Various extruded polystyrene manufacturers.
2. Thickness: As specified on plans. Must meet all jurisdictional requirements and energy calculations. *[**Note to the Building Designer/Architect** – While the thickness of the insulating foam sheathing shall be based on the desired thermal, moisture, and condensation properties of the overall building assembly, additional consideration should be given to the constructability implications associated with specifying particular thickness of building insulation. For example, installation on the exterior side of the above grade wall could have an impact on the attachment of exterior claddings, trim, and windows and doors; installation on the interior side of the foundation walls could have an impact on the attachment of wall coverings and the depth of electrical boxes used.]*
3. Facing: As specified on plans. Must meet all jurisdictional and climate zone requirements. *[**Note to the Building Designer/Architect** – Some rigid cellular foam sheathings use a facing to provide extra protection and rigidity to the board. These facings may also reduce the permeability of the board and therefore the ability of the building assembly, of which it is a component, to dry. Determine whether or not the board contains a facing and the permeability of that facing prior to specifying the board for use.]*

B. Polyisocyanurate Insulating Sheathing

1. Manufacturers:
   a. Dow Chemical Company; THERMAX Brand Sheathing (polyisocyanurate), STYROFOAM SIS Brand Structural Insulated Sheathing. www.dow.com
   b. Johns Manville; AP Foil-Faced Polyisocyanurate Foam Sheathing. www.jm.com
   c. Various polyisocyanurate manufacturers.
2. Thickness: As specified on plans. Must meet all jurisdictional requirements and energy calculations.
3. Facing: As specified on plans. Must meet all jurisdictional and climate zone requirements.

C. Expanded Polystyrene Exterior Insulating Sheathing

1. Manufacturers:
   a. Insulfoam, LLC; InsulFoam Insulations, R-Tech Insulations. www.insulfoam.com
   b. Cellofoam North America, Inc.; Poly Shield Sheathing/Underlayment. www.cellofoam.com
   c. Various expanded polystyrene manufacturers.
2. Thickness: As specified on plans. Must meet all jurisdictional requirements and energy calculations.

3. Facing: As specified on plans. Must meet all jurisdictional and climate zone requirements.

3. PART 3 EXECUTION

3.1 INSPECTION

A. Verify substrate conditions under provisions of Section 013100 – Project Management and Coordination.
B. Verify that substrates and surfaces to which the insulation will be applied are clean, dry, and free of matter that may inhibit insulation adhesion.
C. Verify that the areas to be insulated are dry and do not exhibit any moisture or signs of moisture intrusion. Moisture intrusion conditions found must be corrected.
D. Verify that other work on and within spaces to be insulated is complete prior to insulation application.
E. Notify the Owner's Representative of any existing conditions that will adversely affect execution. Beginning installation means acceptance of substrate and project conditions.
F. Existing housing applications require thorough assessment of existing services and materials, where possible, in locations to receive insulation.
G. Any defects or damages found in the exterior sheathing after installation shall be repaired and/or replaced.

3.2 INSTALLATION

A. General
   1. Comply with the manufacturer's product installation information for each type and for the conditions encountered.
   2. Installers require protective equipment as per the manufacturer's specifications.
   3. All insulation must achieve RESNET-defined Grade 1 installation.
   4. Keep all insulation at least 3 inches away from combustible sources such as chimneys, non-Insulation Contact lighting fixtures, and heated flue pipes. Insulation can be in contact with only materials and services that are rated for insulation contact.

B. Existing Housing Considerations
   1. The National Electric Code forbids the installation of insulation that envelops the conductors of knob and tube wiring.
   2. Remove existing insulation if it impedes air sealing and insulation placement efforts in the application area.

C. Thermal Insulation Installation
   1. Exterior Insulating Sheathing
      a. In areas of very heavy termite infestation (see IRC section R320.4), insulating sheathing must not be placed on exterior walls within 6 inches of the ground.
      b. Insulating sheathing should always be installed on or against dry, clean materials and surfaces to ensure performance to the intended design life of the building system.
      c. A utility knife and straight edge can be used to trim the insulation board to the desired dimension to conform to wall surfaces less than the board width or height.
      d. Install insulation boards vertically with long joints in contact with one another and directly aligned with the wall framing members. Avoid horizontal joints, unless the joints bear on a horizontal framing member.

e. Taping of all sheathing joints on the exterior side is required if insulating sheathing is intended to be used as a water-resistive barrier and/or air barrier. Follow the manufacturer's installation instructions.
f. The insulation foam board joints should be staggered relative to structural sheathing joints (if structural sheathing is used) to reduce air infiltration. *[**Note to the Building Designer/Architect –** In stick-built construction, consider using larger 4x9 sheets of insulation board to effectively cover the sill plates, floor/ceiling junctures, band joist, and headers in a single application.]*
g. Fastening of sheathing shall be in accordance with the manufacturer's installation recommendations, local and regional codes, and as specified in the fastening schedule on the plans. *[**Note to the Building Designer/Architect –** The rigid foam sheathing shall not be used as a nail base for any exterior claddings. All cladding material must be securely fastened directly into a framing member.]*

3.3 COMMISSIONING/TESTING/VERIFICATION

A. General

1. Comply with the verification, testing, and commissioning requirements of the national and/or regional certification programs outlined:
   a. U.S. Environmental Protection Agency Energy Star for Homes Version 3 – Thermal Enclosure System Rater Checklist
   b. U.S. Green Building Council LEED for Homes (January 2008) – Durability Inspection Checklist

Appendix C: Section 07 21 16 Thermal Insulation Batt and Blanket Insulation

Note: The application of this component specification assumes that the architect and building designer are familiar with the building science concepts relating to building system component interactions (e.g., moisture, condensation, and thermal profiles through building assemblies) and the implications associated with specifying particular materials for use. Not all components contained in these specifications are applicable for use in all building systems. It is the responsibility of the building designer and/or architect to select a component that is suitable for each particular building design. This specification is not intended to supersede local, state, or federal codes. This specification assumes that the installer possesses a good working knowledge of the applicable codes and regulations, safety practices, and methods necessary for proper installation. It also assumes that the installer understands the fundamentals of residential construction that affect the installation of insulation materials.

1. PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 – General Requirements, and the Drawings are collectively applicable to this Section.
B. Section 06 10 00: Rough Carpentry
C. Section 07 21 29: Sprayed Insulation
D. Section 07 24 00: Exterior Insulation and Finishing Systems
E. Section 07 26 13: Above-Grade Vapor Retarders
F. Section 07 27 00: Air Barriers

1.2 SECTION INCLUDES

A. Fibrous batt and blanket insulation products installed within above-grade framed wall cavities, floor assemblies, and on the inside face of concrete or masonry basement wall or crawlspace wall assemblies.

1.3 COMPONENT DESCRIPTION

*[**Note to the Building Designer/Architect –** The use of blanket insulation on the interior side of a foundation wall is not considered to be a best practice in energy efficient home building. The thermal performance of draped blanket insulation products, when directly and mechanically fastened to the interior surface of either a basement or crawlspace masonry wall, will be greatly compromised as the blanket will be compressed at the fastener locations. The compressed blanket insulation will not maintain its rated R-value and therefore will have a reduced ability to resist heat flow through the wall assembly. Additionally, blanket insulation products must be properly sealed along the perimeter and any seams to prevent the movement of interior moisture-laden air to behind the insulation, where moisture could condense on cold surfaces. Care must be taken when specifying blanket insulation to ensure that proper air sealing and fastening practices are specified to ensure the optimum performance of the insulation.]*

A. Standards: Performance of the system is designed to meet or exceed the Reference Standards specified:
   1. American Society for Testing and Materials (ASTM)
   2. Federal Specifications (Fed. Spec.)
   3. Underwriters' Laboratories, Inc. (UL)
   4. The North American Insulation Manufacturers Association (NAIMA)

5. Batt and Blanket Insulation
    a. ASTM C 423 – Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
    b. ASTM C 518 – Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
    c. ASTM C 665 – Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
    d. ASTM E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
    e. ASTM E 96 – Standard Test Methods for Water Vapor Transmission of Materials.
    f. ASTM E 119 – Standard Test Methods for Fire Tests of Building Construction and Materials.
    g. ASTM E 136 – Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C.
    h. ASTM C 1320-05 – Standard Practice for Installation of Mineral Fiber Batt and Blanket Thermal Insulation for Light Frame Construction.
    i. Federal Specification HH-I-521F: Insulation Blankets, Thermal (Mineral Fiber, For Ambient Temperatures).
    j. NAIMA – Recommendations for Installation in Residential and Other Light-Frame Construction – Fiber Glass Home Insulation (PUB #B1402).

1.4 SUBMITTALS

A. Submit under the provisions of Section 013300 – Submittal Procedures.
B. Submit the manufacturer's certificate under provisions of Section 014000 – Quality Requirements that products meet or exceed specified requirements.
C. Submit all requests for substitutions under provisions of Section 012500 – Substitution Procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with the manufacturer's product data for handling and storage.
B. Delivery of materials to the site shall be coordinated with the designated construction schedule to minimize the amount of time the materials are stored on site prior to installation. Materials shall not be delivered more than two days prior to being installed.
C. Materials being stored on site shall be protected from exposure to the natural elements. Any material being stored outside of the building enclosure shall be placed on blocking to keep it elevated from sitting in direct contact with the ground and covered with a waterproof, breathable covering such as a canvas tarpaulin to prevent exposure to moisture.
D. Materials that have been damaged upon receipt at the site or exposed to moisture shall be brought to the attention of the site supervisor, removed from the site, and replaced with suitable materials.
E. On-site handling of insulation shall be conducted in compliance with the manufacturer's recommended procedures.

1.6 QUALITY CONTROL

A. Provide certification that insulation has been installed per the requirements of this section and the plan and code listing value. Certification shall be signed by the principal of the insulation Subcontractor and the General Contractor.

1.7 WARRANTY

A. Provide the manufacturer's standard commercial warranty for a period of at least 10 years from the date of manufacture printed on the product. The manufacturer guarantees the actual thermal resistance of the insulation will not vary by more than 10% from its published aged R-value.

1.8 INTENDED PERFORMANCE

A. Building insulation is a critical component in controlling heat flow out of a building when temperature conditions are warmer inside than outside, and into a building when temperature conditions are warmer outside than inside. *[**Note to the Building Designer/Architect –** In existing houses the addition of insulation into wall and band joist cavities will affect the drying potential of the assembly. Prior to the application of insulation, wood and masonry materials could dry easily because there is no insulation impeding the movement of heat flow. The new drying potential of the wall assembly must be considered so that moisture does not become trapped, leading to assembly component deterioration. This means that all moisture and bulk water penetration mechanisms into the assembly must be successfully managed (with the use of flashing, vapor retarders, capillary breaks, etc.) so that bulk water does not enter the assembly, and water vapor flow is controlled.]* Several important benefits are associated with adequate levels of correctly installed building insulation: energy is saved, and the cost of operating a house is reduced; the space conditioning system operates more efficiently and effectively, and occupant thermal comfort is increased because interior temperatures are more consistently near desired levels; and enclosure surface temperatures are controlled, reducing the risk of cold-weather condensation occurring on building materials. *[**Note to the Building Designer/Architect –** Vapor retarders are a critical component of moisture control within building assemblies. Specification and placement of them within the building assembly will vary, based on regional and climatic conditions. Heat flows from warm to cool areas, and, in general, the vapor retarder should be placed on the predominantly warm side of the assembly to prevent moisture from migrating, with the heat flow, to the cold side of the assembly where it could reach its dew point and condense.]* Building insulation must be kept dry from exterior and interior moisture sources and installed with no gaps, voids, or compression to achieve its rated insulating value.

B. The home owner should be advised that the relative humidity within the living area should be kept at or below 40% R.H. when outside temperatures fall below 32°F.

2. PART 2 PRODUCTS

2.1 BATT AND BLANKET INSULATION MATERIALS

*[**Note to the Building Designer/Architect –** The kraft paper or standard foil vapor retarder facings on many batt or blanket insulation products must be covered with gypsum or interior paneling because of fire considerations. Some blanket products are available without these facings or with a special flame-resistant facing (labeled FS25 or flame spread index 25) for places where the facing would not be covered. Sometimes the flame-resistant cover can be purchased separately from the insulation. Special fiberglass blanket products also are available for basement walls that require less framing and can be left exposed. These blankets have a flame-resistant facing and are labeled to show that they comply with ASTM C 665, Type II, Class A. (http://www.ornl.gov/sci/roofs+walls/insulation/ins_06.html)]*

A. Batt Insulation
   1. Manufacturers:
      a. CertainTeed Corporation; Certainteed Fiber Glass Building Insulation. www.certainteed.com
      b. Johns Manville Corporation; Fiber Glass Building Insulation. www.jm.com.
      c. Owens Corning Corporation; PINK FIBERGLAS Insulation. www.owenscorning.com
      d. Roxul; Roxul ComfortBatt. www.roxul.com
   2. Thickness: As specified on plans. Must meet all jurisdictional requirements and energy calculations.
   3. Existing Housing Application: Existing walls can receive a fiberglass batt application.

B. Blanket Insulation
   1. Manufacturers:
      a. Guardian Building Products; Basement R-11 Fiber Glass Wall Insulation; White Polypropylene Scrim Kraft (PSK) – Perforated; Silver Foil Scrim Kraft (FSK) – Perforated. www.guardianbp.com.
      b. CertainTeed Corporation; Certainteed Basement and Masonry Wall Insulation. www.certainteed.com
   2. Fire-resistance Characteristics: Products must have a flame spread index that does not exceed 25 and a smoke developed index that does not exceed 50 passing ASTM E 136 for combustion characteristics.
   3. Thickness: 3½ inches. Available in 48-inch and 88-inch widths. Must meet all jurisdictional requirements and energy calculations.
   4. Existing Housing Application: Existing basement or crawlspace walls can receive a fiberglass blanket application. *[**Note to the Building Designer/Architect** – If insulating the walls of a crawlspace using blanket insulation, consider that the crawlspace must be unvented and properly sealed to be airtight with a well-maintained air barrier. Refer to the Crawlspace Insulation Technology Fact Sheet for guidance on design details. (http://www.ornl.gov/sci/roofs+walls/insulation/fact%20sheets/crawlspace%20insulation%20technology.pdf)]*
   5. Facing: No additional facings required.

3. PART 3 EXECUTION

3.1 INSPECTION

A. Verify substrate conditions under provisions of Section 013100 – Project Management and Coordination.
B. Verify that surfaces are clean, dry, and free of matter that may inhibit insulation installation.
C. Verify that the areas to be insulated are dry and do not exhibit any moisture or signs of moisture intrusion. Moisture intrusion conditions found must be corrected.
D. Verify the moisture content of the framing/sheathing prior to insulating, and ensure that the levels are below 15%.
E. Verify that other work on and within spaces to be insulated is complete prior to insulation application.
F. Notify the Owner's Representative of any existing conditions that will adversely affect execution. Beginning installation means acceptance of substrate and project conditions.

G. Existing housing applications require thorough assessment of existing services and materials, where possible, in locations to receive insulation.

3.2 INSTALLATION

A. General

1. Comply with the manufacturer's product installation information for each type and for the conditions encountered.
2. Installers require protective equipment as per the manufacturer's specifications.
3. All insulation must achieve RESNET-defined Grade 1 installation.
4. Keep all insulation at least 3 inches away from combustible sources such as chimneys, non-Insulation Contact lighting fixtures, and heated flue pipes. Insulation can be in contact with only materials and services that are rated for insulation contact.

B. Existing Housing Considerations

1. The National Electric Code forbids the installation of insulation that envelops the conductors of knob and tube wiring.
2. Remove existing insulation if it impedes air sealing and insulation placement efforts in the application area.

C. Thermal Insulation Installation

1. Blanket Insulation

*[**Note to the Building Designer/Architect** – When a fiberglass blanket is used to insulate the walls of an unventilated crawlspace, it is sometimes necessary to attach wood furring strips to the walls by nailing or bonding. The insulation can then be stapled or tacked into place. Alternatively, the insulation can be fastened to the sill plate and draped down the wall. Insulation should continue from the wall over the floor of the crawlspace for about 2 feet on top of the required ground vapor retarder. Because the insulation will be exposed, be sure to use a product with the appropriate flame spread rating. (http://www.ornl.gov/sci/roofs+walls/insulation/ins_06.html)]*

a. Apply in sufficient thickness to achieve the specified performance.
b. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice, rain, or snow.
c. Coordinate with plumbing, electrical, and other services to be located away from the wall being insulated so that insulation can be installed unobstructed.

3.3 COMMISSIONING/TESTING/VERIFICATION

A. General

1. Comply with the verification, testing, and commissioning requirements of the national and/or regional certification programs outlined:
   a. U.S. Environmental Protection Agency Energy Star for Homes Version 3 – Thermal Enclosure System Rater Checklist
   b. NAIMA 25 Checkpoints for Inspecting Insulation Jobs (BI497)
   c. U.S. Green Building Council LEED for Homes (January 2008) – Durability Inspection Checklist

Appendix D: Section 07 21 19 Thermal Insulation Foamed-in-Place Insulation

Note: The application of this component specification assumes that the architect and building designer are familiar with the building science concepts relating to building system component interactions (e.g., moisture, condensation, and thermal profiles through building assemblies) and the implications associated with specifying particular materials for use. Not all components contained in these specifications are applicable for use in all building systems. It is the responsibility of the building designer and/or architect to select a component that is suitable for each particular building design. This specification is not intended to supersede local, state, or federal codes. This specification assumes that the installer possesses a good working knowledge of the applicable codes and regulations, safety practices, and methods necessary for proper installation. It also assumes that the installer understands the fundamentals of residential construction that affect the installation of insulation materials.

1. PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 – General Requirements, and the Drawings are collectively applicable to this Section.
B. Section 06 10 00: Rough Carpentry
C. Section 07 21 29: Sprayed Insulation
D. Section 07 24 00: Exterior Insulation and Finishing Systems
E. Section 07 26 13: Above-Grade Vapor Retarders
F. Section 07 27 00: Air Barriers

1.2 SECTION INCLUDES

A. Polyurethane Spray Foam Insulation foamed in place in exterior wall cavities.

1.3 COMPONENT DESCRIPTION

A. Standards: Performance of the system is designed to meet or exceed the Reference Standards specified:
   1. American Society for Testing and Materials (ASTM)
   2. Federal Specifications (Fed. Spec.)
   3. Underwriters' Laboratories, Inc. (UL)
   4. Polyurethane Spray Foam Insulation
      a. ASTM C 518 – Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
      b. ASTM D 2863 – Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
      c. ASTM C 1029 – Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation
      d. ASTM D 1621 – Standard Test Method for Compressive Properties of Rigid Cellular Plastics
      e. ASTM D 1622 – Standard Test Method for Apparent Density of Rigid Cellular Plastics
      f. ASTM D 6226 – Standard Test Method for Open Cell Content of Rigid Cellular Plastics

1.4 SUBMITTALS

A. Submit under the provisions of Section 013300 – Submittals.
B. Submit the manufacturer's certificate under provisions of Section 014000 – Quality Control, that products meet or exceed specified requirements.
C. Submit all requests for substitutions under provisions of Section 012500 – Product Options and Substitutions.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with the manufacturer's product data for handling and storage.
B. Delivery of materials to the site shall be coordinated with the designated construction schedule to minimize the amount of time the materials are stored on site prior to installation. Materials shall not be delivered more than two days prior to being installed.
C. Materials being stored on site shall be protected from exposure to the natural elements. Any material being stored outside of the building enclosure shall be placed on blocking to keep it elevated from sitting in direct contact with the ground and covered with a waterproof, breathable covering such as a canvas tarpaulin to prevent exposure to moisture.
D. Materials that have been damaged upon receipt at the site or exposed to moisture shall be brought to the attention of the site supervisor, removed from the site, and replaced with suitable materials.
E. On-site handling of insulation shall be conducted in compliance with the manufacturer's recommended procedures.

1.6 QUALITY ASSURANCE

A. Retain ASTM test method below for each product in Part 2. Provide insulation and related materials with the fire-test-response characteristics required by building codes and regulations, as determined by testing identical products per ASTM E 84 for surface-burning characteristics and other methods indicated with the product, by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
    1. Surface burning characteristics: ASTM E 84.
    2. Fire-resistance ratings: ASTM E 119.
    3. Combustion characteristics: ASTM E 136.

1.7 QUALITY CONTROL

A. Provide certification that insulation has been installed per the requirements of this section and the plan and code listing value. Certification shall be signed by the principal of the insulation Subcontractor and the General Contractor.

1.8 WARRANTY

A. Provide the manufacturer's standard commercial warranty for a period of at least 10 years from the date of manufacture printed on the product. The manufacturer guarantees the actual thermal resistance of the insulation will not vary by more than 10% from its published aged R-value.

1.9 INTENDED PERFORMANCE

A. Building insulation is a critical component in controlling heat flow out of a building when temperature conditions are warmer inside than outside, and into a building when temperature conditions are warmer outside than inside. *[**Note to the Building Designer/Architect** – In existing houses the addition of insulation into exterior wall and band joist cavities will affect the drying potential of the assembly. Prior to the*

application of insulation, wood and masonry materials could dry easily because there is no insulation impeding the movement of heat flow. The new drying potential of the wall assembly must be considered so that moisture does not become trapped, leading to assembly component deterioration. This means that all moisture and bulk water penetration mechanisms into the assembly must be successfully managed (with the use of flashing, vapor retarders, capillary breaks, etc.) so that they do not enter the assembly.] Several important benefits are associated with adequate levels of correctly installed building insulation: energy is saved, and the cost of operating a house is reduced; the space conditioning system operates more efficiently and effectively, and occupant thermal comfort is increased because interior temperatures are more consistently near desired levels; and enclosure surface temperatures are controlled, reducing the risk of cold-weather condensation occurring on building materials. *[**Note to the Building Designer/Architect** – Vapor retarders are a critical component of moisture control within building assemblies. Specification and placement of them within the building assembly will vary, based on regional and climatic conditions. Heat flows from warm to cool areas, and, in general, the vapor retarder should be placed on the predominantly warm side of the assembly to prevent moisture from migrating, with the heat flow, to the cold side of the assembly where it could reach its dew point and condense.]* Building insulation must be kept dry from exterior and interior moisture sources and installed with no gaps or voids to achieve its rated insulating value. Furthermore, polyurethane spray foam insulation products contribute to improved building envelope air tightness and may act as a vapor retarder. *[**Note to the Building Designer/Architect** – The water vapor transmission characteristics of each type of polyurethane spray foam insulation must be considered in assembly designs. For instance, closed cell spray foam insulation can act as a class I or II vapor retarder, depending on insulation thickness.]*

B. The home owner should be advised that the relative humidity within the living area should be kept at or below 40% R.H. when outside temperatures fall below 32°F.

2. PART 2 PRODUCTS

2.1 SPRAYED INSULATION MATERIALS FOR NEW AND EXISTING HOUSING

A. Polyurethane Spray Foam Insulation

1. Manufacturers:
   a. Bayer MaterialScience; Bayseal CC Closed Cell, Bayseal OC Open Cell. www.spfbayermaterialscience.com.
   b. CertainTeed Corporation; CertaSpray Closed Cell Foam, CertaSpray Open Cell Foam. www.certainteed.com.
   c. DOW Corporation; STYROFOAM Brand Spray Polyurethane Foam (RS Series), FROTH-PAK Foam Insulation. www.dow.com.
   d. Icynene Inc.; ICYNENE LD-C-50 Spray Formula, LD-CP-50 Pour Fill Formula, ICYNENE LD-R-50 Renewable Spray Formula, ICYNENE MD-R-200 Spray Formula with Recycled Content, ICYNENE MD-C-200 Closed Cell Formula. www.icynene.com.
   e. Johns Manville Corporation; JM Corbond III Closed-cell Spray Polyurethane Foam, JM Corbond Multi-Climate Solution, JM Open-cell Spray Foam. www.jm.com.
2. Thickness: As specified on plans. Must meet all jurisdictional requirements and energy calculations.

3. Existing Housing Application: Existing walls can receive a pour fill variation of spray foam insulation that is placed through an opening at the top of the wall.

3. PART 3 EXECUTION

3.1 INSPECTION

A. Verify that surfaces are clean, dry, and free of matter that may adversely affect the adhesion of the spray foam insulation.
B. Verify that the areas to be insulated are dry and do not exhibit any moisture or signs of moisture intrusion. Moisture intrusion conditions found must be corrected.
C. Verify the moisture content of the framing/sheathing prior to insulating, and ensure that the levels are below 15%.
D. Verify that other work on and within spaces to be insulated is complete prior to insulation application.
E. Beginning installation means acceptance of substrate and project conditions.
F. Existing housing applications require thorough assessment of existing services and materials, where possible, in locations to receive insulation.

3.2 INSTALLATION

A. General
   1. Comply with the manufacturer's product installation information for each type and for the conditions encountered.
   2. Installers require protective equipment as per the manufacturer's specifications.
   3. Product must be applied by a qualified applicator.
   4. All insulation must achieve RESNET-defined Grade 1 installation.
   5. Keep all insulation at least 3 inches away from combustible sources such as chimneys, non-Insulation Contact lighting fixtures, and heated flue pipes. Insulation can be in contact with only materials and services that are rated for insulation contact.

B. Existing Housing Considerations
   1. The National Electric Code forbids the installation of spray foam insulation that envelops the conductors of knob and tube wiring.
   2. Remove existing insulation if it impedes air sealing and insulation placement efforts in the application area.

C. Thermal Insulation Installation
   1. Polyurethane Spray Foam Insulation
      a. Apply in sufficient thickness to achieve the specified performance and uniform monolithic density without voids.
      b. Spray foam insulations are restricted on the maximum thickness of each application layer (lift). Refer to the manufacturer's specifications for details.
      c. Certain spray foam insulations may be installed in existing wall cavities as designated by the manufacturer and subject to product manufacturer requirements.
      d. Do not install spray foam insulation in areas where it will be in contact with equipment or materials with operating temperatures of 180°F (82° C) or greater.

3.3 COMMISSIONING/TESTING/VERIFICATION

A. General

1. Comply with the verification, testing, and commissioning requirements of the national and/or regional certification programs outlined:
   a. U.S. Environmental Protection Agency Energy Star for Homes Version 3 – Thermal Enclosure System Rater Checklist
   b. U.S. Green Building Council LEED for Homes (January 2008) – Durability Inspection Checklist

Appendix E: Section 07 21 23 Thermal Insulation Loose-Fill Insulation

Note: The application of this component specification assumes that the architect and building designer are familiar with the building science concepts relating to building system component interactions (e.g., moisture, condensation, and thermal profiles through building assemblies) and the implications associated with specifying particular materials for use. Not all components contained in these specifications are applicable for use in all building systems. It is the responsibility of the building designer and/or architect to select a component that is suitable for each particular building design. This specification is not intended to supersede local, state, or federal codes. This specification assumes that the installer possesses a good working knowledge of the applicable codes and regulations, safety practices, and methods necessary for proper installation. It also assumes that the installer understands the fundamentals of residential construction that affect the installation of insulation materials.

1. PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 – General Requirements, and the Drawings are collectively applicable to this Section.
B. Section 06 10 00: Rough Carpentry
C. Section 07 24 00: Exterior Insulation and Finishing Systems
D. Section 07 26 13:Above-Grade Vapor Retarders
E. Section 07 27 00: Air Barriers

1.2 SECTION INCLUDES

A. Fibrous insulation products pneumatically blown into attic and floor assemblies:
1. Loose-fill fiberglass
2. Loose-fill cellulose

1.3 COMPONENT DESCRIPTION

A. Standards: Performance of the system is designed to meet or exceed the Reference Standards specified:
1. American Society for Testing and Materials (ASTM)
2. Federal Specifications (Fed. Spec.)
3. The Cellulose Insulation Manufacturers Association (CIMA)
4. Underwriters' Laboratories, Inc. (UL)
5. The North American Insulation Manufacturers Association (NAIMA)
6. Loose-Fill Insulation
   a. ASTM C 739-03e1 – Standard Specification for Cellulosic Fiber Loose-Fill Thermal Insulation; 2005b.
   b. ASTM C 764-04 – Standard Specification for Mineral Fiber Loose-fill Insulation.
   c. ASTM C 1015-02 – Standard Practice for Installation of Cellulosic and Mineral Fiber Loose-Fill Thermal Insulation; 2006.
   d. ASTM C 1374-03 – Standard Test Method for Determination of Installed Thickness of Pneumatically Applied Loose-Fill Building Insulation.
   e. ASTM C 1574-04 – Standard Guide for Determining Blown Density of Pneumatically Applied Loose-Fill Mineral Fiber Thermal Insulation.
   f. NAIMA – Recommendations for Installation in Residential and Other Light-Frame Construction – Fiber Glass Home Insulation (PUB #B1402).

g. NAIMA – Recommendations for Installation in Residential and Other Light-Frame Construction – Fiber Glass Loose Fill Insulation (PUB #B1403).

1.4 SUBMITTALS

A. Submit under the provisions of Section 013300 – Submittal Procedures.
B. Submit the manufacturer's certificate under provisions of Section 014000 – Quality Requirements that products meet or exceed specified requirements.
C. Submit all requests for substitutions under provisions of Section 012500 – Substitution Procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with the manufacturer's product data for handling and storage.
B. Delivery of materials to the site shall be coordinated with the designated construction schedule to minimize the amount of time the materials are stored on site prior to installation. Materials shall not be delivered more than two days prior to being installed.
C. Materials being stored on site shall be protected from exposure to the natural elements. Any material being stored outside of the building enclosure shall be placed on blocking to keep it elevated from sitting in direct contact with the ground and covered with a waterproof, breathable covering such as a canvas tarpaulin to prevent exposure to moisture.
D. Materials that have been damaged upon receipt at the site or exposed to moisture shall be brought to the attention of the site supervisor, removed from the site, and replaced with suitable materials.
E. On-site handling of insulation shall be conducted in compliance with the manufacturer's recommended procedures.

1.6 QUALITY ASSURANCE

A. Retain ASTM test method below for each product in Part 2. Provide insulation and related materials with the fire-test-response characteristics required by building codes and regulations, as determined by testing identical products per ASTM E 84 for surface-burning characteristics and other methods indicated with product, by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
    1. Surface burning characteristics: ASTM E 84.
    2. Fire-resistance ratings: ASTM E 119.
    3. Combustion characteristics: ASTM E 136.

1.7 QUALITY CONTROL

A. Provide certification that insulation has been installed per the requirements of this section and the plan and code listing value. Certification shall be signed by the principal of the insulation Subcontractor and the General Contractor.

1.8 WARRANTY

A. Provide the manufacturer's standard commercial warranty for a period of at least 10 years from the date of manufacture printed on the product. The manufacturer guarantees the actual thermal resistance of the insulation will not vary by more than 10% from its published aged R-value.

1.9 INTENDED PERFORMANCE

A. Building insulation is a critical component in controlling heat flow out of a building when temperature conditions are warmer inside than outside, and into a building when temperature conditions are warmer outside than inside. *[**Note to the Building Designer/Architect** – In existing houses the addition of insulation into attics will affect the drying potential of the assembly. Prior to the*

application of insulation, wood could dry easily because there is no insulation impeding the movement of heat flow. The new drying potential of the attic assembly must be considered so that moisture does not become trapped, leading to assembly component deterioration. This means that all moisture and bulk water penetration mechanisms into the attic must be successfully managed (with the use of flashing and roofing) so that bulk water does not enter the assembly and water vapor flow is controlled.] Several important benefits are associated with adequate levels of correctly installed building insulation: energy is saved, and the cost of operating a house is reduced; the space conditioning system operates more efficiently and effectively, and occupant thermal comfort is increased because interior temperatures are more consistently near desired levels; and enclosure surface temperatures are controlled, reducing the risk of cold-weather condensation occurring on building materials. *[**Note to the Building Designer/Architect** – Vapor retarders are a critical component of moisture control within building assemblies. Specification and placement of them within the building assembly will vary, based on regional and climatic conditions. Heat flows from warm to cool areas, and, in general, the vapor retarder should be placed on the predominantly warm side of the assembly to prevent moisture from migrating, with the heat flow, to the cold side of the assembly where it could reach its dew point and condense.]* Building insulation must be kept dry from exterior and interior moisture sources and installed with no gaps, voids, or compression to achieve its rated insulating value.

B. The home owner should be advised that the relative humidity within the living area should be kept at or below 40% R.H. when outside temperatures fall below 32°F.

2. PART 2 PRODUCTS

2.1 LOOSE-FILL INSULATION MATERIALS FOR NEW AND EXISTING HOUSING

A. Loose-Fill Insulation

1. Manufacturers:
   a. CertainTeed Corporation; www.certainteed.com.
   b. Green Fiber; GreenFiber Stabilized Attic Insulation, Loose Fill Attic Insulation. www.greenfiber.com.
   c. Johns Manville Corporation; Climate Pro Loose-Fill Insulation. www.jm.com.
   d. Nu-Wool Company, Inc.; Nu-Wool Premium Cellulose Insulation. www.nuwool.com
   e. Owens Corning Corporation; PROPINK LooseFill insulation. www.owenscorning.com
2. Thickness: As specified on plans. Must meet all jurisdictional requirements and energy calculations. *[**Note to the Building Designer/Architect** – In existing housing applications where new insulation is placed on existing insulation, such as in an attic application, the older insulation will become compressed. As a result, the thermal performance of the existing insulation will decrease. Compensate for this loss in thermal performance by increasing the thickness of new insulation to ensure that the total thermal performance specification for the application is achieved.]*

B. Attic insulation baffle

1. Manufacturers:
   a. Plastic (AccuVent by Brentwood Industries), or approved equal.

3. PART 3 EXECUTION

3.1 INSPECTION

A. Verify substrate conditions under provisions of Section 013100 – Project Management and Coordination.

B. Verify that surfaces are clean, dry, and free of matter that may inhibit insulation installation.

C. Verify that the areas to be insulated are dry and do not exhibit any moisture or signs of moisture intrusion. Moisture intrusion conditions found must be corrected.

D. Verify the moisture content of the framing prior to insulating, and ensure that the levels are below 15%.

E. Verify that other work on and within spaces to be insulated is complete prior to insulation application.

F. Notify the Owner's Representative of any existing conditions that will adversely affect execution. Beginning installation means acceptance of substrate and project conditions.

G. Existing housing applications require thorough assessment of existing services and materials, where possible, in locations to receive insulation.

3.2 INSTALLATION

A. General

1. Comply with the manufacturer's product installation information for each type and for the conditions encountered.
2. Installers require protective equipment as per the manufacturer's specifications.
3. All insulation must achieve RESNET-defined Grade 1 installation.
4. Keep all insulation at least 3 inches away from combustible sources such as chimneys, non-Insulation Contact lighting fixtures, and heated flue pipes. Insulation can be in contact with only materials and services that are rated for insulation contact.

B. Existing Housing Considerations

1. The National Electric Code forbids the installation of insulation that envelops the conductors of knob and tube wiring.
2. Remove existing insulation if it impedes air sealing and insulation placement efforts in the application area.

C. Thermal Insulation Installation

1. Loose-Fill Insulation
   a. Apply in sufficient thickness to achieve the specified performance.
   b. Apply insulation, building up to the required thickness with as many passes as necessary to create monolithic coverage of uniform density.
   c. Ensure the use of depth gauges on horizontal surfaces with a spacing of no more than 1 per 400 ft^2 to aid the installer in application of the appropriate depth of insulation.

3.3 COMMISSIONING/TESTING/VERIFICATION

A. General

1. Comply with the verification, testing, and commissioning requirements of the national and/or regional certification programs outlined:
   a. U.S. Environmental Protection Agency Energy Star for Homes Version 3 – Thermal Enclosure System Rater Checklist
   b. NAIMA 25 Checkpoints for Inspecting Insulation Jobs (BI497)
   c. U.S. Green Building Council LEED for Homes (January 2008) – Durability Inspection Checklist

Appendix F: Section 07 21 29 Thermal Insulation Sprayed Insulation

Note: The application of this component specification assumes that the architect and building designer are familiar with the building science concepts relating to building system component interactions (e.g., moisture, condensation, and thermal profiles through building assemblies) and the implications associated with specifying particular materials for use. Not all components contained in these specifications are applicable for use in all building systems. It is the responsibility of the building designer and/or architect to select a component that is suitable for each particular building design. This specification is not intended to supersede local, state, or federal codes. This specification assumes that the installer possesses a good working knowledge of the applicable codes and regulations, safety practices, and methods necessary for proper installation. It also assumes that the installer understands the fundamentals of residential construction that affect the installation of insulation materials.

1. PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 – General Requirements, and the Drawings are collectively applicable to this Section.
B. Section 06 10 00: Rough Carpentry
C. Section 07 24 00: Exterior Insulation and Finishing Systems
D. Section 07 26 13: Above-Grade Vapor Retarders
E. Section 07 27 00: Air Barriers

1.2 SECTION INCLUDES

A. Polyurethane Spray Foam Insulation sprayed into exterior wall cavities or attic assemblies.

1.3 COMPONENT DESCRIPTION

A. Standards: Performance of the system is designed to meet or exceed the Reference Standards specified:
    1. American Society for Testing and Materials (ASTM)
    2. Federal Specifications (Fed. Spec.)
    3. Underwriters' Laboratories, Inc. (UL)
    4. Polyurethane Spray Foam Insulation
        a. ASTM C 518 – Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
        b. ASTM D 2863 – Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
        c. ASTM C 1029 – Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation
        d. ASTM D 1621 – Standard Test Method for Compressive Properties of Rigid Cellular Plastics
        e. ASTM D 1622 – Standard Test Method for Apparent Density of Rigid Cellular Plastics
        f. ASTM D 6226 – Standard Test Method for Open Cell Content of Rigid Cellular Plastics

1.4 SUBMITTALS

A. Submit under the provisions of Section 013300 – Submittal Procedures.

B. Submit the manufacturer's certificate under provisions of Section 014000 – Quality Requirements that products meet or exceed specified requirements.
C. Submit all requests for substitutions under provisions of Section 012500 – Substitution Procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with the manufacturer's product data for handling and storage.
B. Delivery of materials to the site shall be coordinated with the designated construction schedule to minimize the amount of time the materials are stored on site prior to installation. Materials shall not be delivered more than two days prior to being installed.
C. Materials being stored on site shall be protected from exposure to the natural elements. Any material being stored outside of the building enclosure shall be placed on blocking to keep it elevated from sitting in direct contact with the ground and covered with a waterproof, breathable covering such as a canvas tarpaulin to prevent exposure to moisture.
D. Materials that have been damaged upon receipt at the site or exposed to moisture shall be brought to the attention of the site supervisor, removed from the site, and replaced with suitable materials.
E. On-site handling of insulation shall be conducted in compliance with the manufacturer's recommended procedures.

1.6 QUALITY ASSURANCE

A. Retain ASTM test method results below for each product in Part 2. Provide insulation and related materials with the fire-test-response characteristics required by building codes and regulations, as determined by testing identical products per ASTM E 84 for surface-burning characteristics and other methods indicated with product, by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
    1. Surface burning characteristics: ASTM E 84.
    2. Fire-resistance ratings: ASTM E 119.
    3. Combustion characteristics: ASTM E 136.

1.7 QUALITY CONTROL

A. Provide certification that insulation has been installed per the requirements of this section and the plan and code listing value. Certification shall be signed by the principal of the insulation Subcontractor and the General Contractor.

1.8 WARRANTY

A. Provide the manufacturer's standard commercial warranty for a period of at least 10 years from the date of manufacture printed on the product. The manufacturer guarantees the actual thermal resistance of the insulation will not vary by more than 10% from its published aged R-value.

1.9 INTENDED PERFORMANCE

A. Building insulation is a critical component in controlling heat flow out of a building when temperature conditions are warmer inside than outside, and into a building when temperature conditions are warmer outside than inside. *[**Note to the Building Designer/Architect –** In existing houses the addition of insulation into exterior wall, band joist, and attic cavities will affect the drying potential of the assembly. In walls, prior to the application of insulation, wood and masonry materials could dry easily because there is no insulation impeding the movement of heat flow. The new drying potential of the wall or attic assembly must be considered so that moisture*

does not become trapped, leading to assembly component deterioration. This means that all moisture and bulk water penetration mechanisms into the assembly must be successfully managed (with the use of flashing, roofing. vapor retarders, capillary breaks, etc.) so that bulk water does not enter the assembly and water vapor flow is controlled.] Several important benefits are associated with adequate levels of correctly installed building insulation: energy is saved, and the cost of operating a house is reduced; the space conditioning system operates more efficiently and effectively, and occupant thermal comfort is increased because interior temperatures are more consistently near desired levels; and enclosure surface temperatures are controlled, reducing the risk of cold-weather condensation occurring on building materials. *[**Note to the Building Designer/Architect –** Vapor retarders are a critical component of moisture control within building assemblies. Specification and placement of them within the building assembly will vary, based on regional and climatic conditions. Heat flows from warm to cool areas, and, in general, the vapor retarder should be placed on the predominantly warm side of the assembly to prevent moisture from migrating, with the heat flow, to the cold side of the assembly where it could reach its dew point and condense.]* Building insulation must be kept dry from exterior and interior moisture sources and installed with no gaps, voids, or compression to achieve its rated insulating value. Furthermore, polyurethane spray foam insulation products contribute to improved building envelope air tightness and may act as a vapor retarder. *[**Note to the Building Designer/Architect –** The water vapor transmission characteristics of each type of polyurethane spray foam insulation must be considered in assembly designs. For instance, closed cell spray foam insulation can act as a class I or II vapor retarder, depending on insulation thickness.]*

B. The home owner should be advised that the relative humidity within the living area should be kept at or below 40% R.H. when outside temperatures fall below 32°F.

2. PART 2 PRODUCTS

2.1 SPRAYED INSULATION

A. Polyurethane Spray Foam Insulation

1. Manufacturers:
   a. Bayer MaterialScience; Bayseal CC Closed Cell, Bayseal OC Open Cell. www.spfbayermaterialscience.com.
   b. CertainTeed Corporation; CertaSpray Closed Cell Foam, CertaSpray Open Cell Foam. www.certainteed.com.
   c. DOW Corporation; STYROFOAM Brand Spray Polyurethane Foam (RS Series) FROTH-PAK Foam Insulation. www.dow.com.
   d. Icynene Inc.; ICYNENE LD-C-50 Spray Formula, LD-CP-50 Pour-Fill Formula, ICYNENE LD-R-50 Renewable Spray Formula, ICYNENE MD-R-200 Spray Formula with Recycled Content, ICYNENE MD-C-200 Closed-Cell Formula. www.icynene.com.
   e. Johns Manville Corporation; JM Corbond III Closed-cell Spray Polyurethane Foam, JM Corbond Multi-Climate Solution, JM Open-cell Spray Foam. www.jm.com
2. Thickness: As specified on plans. Must meet all jurisdictional requirements and energy calculations.

B. Attic insulation baffle

1. Manufacturers:
   a. Plastic (AccuVent by Brentwood Industries), or approved equal.

3. PART 3 EXECUTION

3.1 INSPECTION

A. Verify substrate conditions under provisions of Section 013100 – Project Management and Coordination.
B. Verify that surfaces are clean, dry, and free of matter that may adversely affect the adhesion of the spray foam insulation.
C. Verify that the areas to be insulated are dry and do not exhibit any moisture or signs of moisture intrusion. Moisture intrusion conditions found must be corrected.
D. Verify the moisture content of the framing/sheathing prior to insulating, and ensure that the levels are below 15%.
E. Verify that other work on and within spaces to be insulated is complete prior to insulation application.
F. Notify the Owner's Representative of any existing conditions that will adversely affect execution. Beginning installation means acceptance of substrate and project conditions.
G. Existing housing applications require thorough assessment of existing services and materials, where possible, in locations to receive insulation.

3.2 INSTALLATION

A. General

1. Comply with the manufacturer's product installation information for each type and for the conditions encountered.
2. Installers require protective equipment as per the manufacturer's specifications.
3. Product must be applied by a qualified applicator.
4. All insulation must achieve RESNET-defined Grade 1 installation.
5. Keep all insulation at least 3 inches away from combustible sources such as chimneys, non-Insulation Contact lighting fixtures, and heated flue pipes. Insulation can be in contact with only materials and services that are rated for insulation contact.

B. Existing Housing Considerations

1. The National Electric Code forbids the installation of spray foam insulation that envelops the conductors of knob and tube wiring.
2. Remove existing insulation if it impedes air sealing and insulation placement efforts in the application area.

C. Thermal Insulation Installation

1. Polyurethane Spray Foam Insulation
   a. Install in indicated exterior walls and ceiling areas.
   b. Apply in sufficient thickness to achieve the specified performance and uniform monolithic density without voids.
   c. Spray foam insulations are restricted on the maximum thickness of each application layer (lift). Refer to the manufacturer's specifications for details.
   d. Certain spray foam insulations may be installed in existing wall cavities as designated by the manufacturer and subject to product manufacturer requirements.
   e. Building codes require that spray foam insulations be separated from the interior of a building by a thermal barrier, which is applied over the insulation to slow thermal rise during a fire, and delay its involvement in a fire. A building code definition of an approved thermal barrier is one that is equal in fire resistance to ½-inch gypsum board.

f. When spray foam insulations are installed within attics or crawlspaces where entry is made only for service of utilities, an ignition barrier (e.g., intumescent coating) may be required in accordance with International Building Code Section 2603.4.1.6 and International Residential Code Section R314.5.4, as applicable. Refer to the manufacturer's specifications for details.

3.3 COMMISSIONING/TESTING/VERIFICATION

A. General

1. Comply with the verification, testing, and commissioning requirements of the national and/or regional certification programs outlined:
   a. U.S. Environmental Protection Agency Energy Star for Homes Version 3 – Thermal Enclosure System Rater Checklist
   b. U.S. Green Building Council LEED for Homes (January 2008) – Durability Inspection Checklist

Appendix G: Section 07 21 26 Thermal Insulation Damp Blown Insulation

Note: The application of this component specification assumes that the architect and building designer are familiar with the building science concepts relating to building system component interactions (e.g., moisture, condensation, and thermal profiles through building assemblies) and the implications associated with specifying particular materials for use. Not all components contained in these specifications are applicable for use in all building systems. It is the responsibility of the building designer and/or architect to select a component that is suitable for each particular building design. This specification is not intended to supersede local, state, or federal codes. This specification assumes that the installer possesses a good working knowledge of the applicable codes and regulations, safety practices, and methods necessary for proper installation. It also assumes that the installer understands the fundamentals of residential construction that affect the installation of insulation materials.

1. PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 – General Requirements, and the Drawings are collectively applicable to this Section.
B. Section 06 10 00: Rough Carpentry
C. Section 07 21 29: Sprayed Insulation
D. Section 07 24 00: Exterior Insulation and Finishing Systems
E. Section 07 26 13: Above-Grade Vapor Retarders
F. Section 07 27 00: Air Barriers

1.2 SECTION INCLUDES

A. Fibrous insulation products pneumatically blown damp into exterior wall cavities:
   1. Blown in fiberglass
   2. Blown in cellulose

1.3 COMPONENT DESCRIPTION

*[**Note to the Building Designer/Architect** – Blown insulation is not recommended for use in sidewalls below grade or for filling cavities of masonry walls. The Designer/Architect should be familiar with and refer to the appropriate sections of the National Electric Codes, ASTM standards, CIMA Technical Bulletins, and International Residential Code (IRC)/International Building Code (IBC) for more information.]*

A. Standards: Performance of the system is designed to meet or exceed the Reference Standards specified:
   1. American Society for Testing and Materials (ASTM)
   2. Federal Specifications (Fed. Spec.)
   3. The Cellulose Insulation Manufacturers Association (CIMA)
   4. Underwriters' Laboratories, Inc. (UL)
   5. The North American Insulation Manufacturers Association (NAIMA)
   6. Blown Insulation
      a. ASTM C 739-03e1 – Standard Specification for Cellulosic Fiber Loose-Fill Thermal Insulation; 2005b.
      b. ASTM C 764-04 – Standard Specification for Mineral Fiber Loose-Fill Insulation; 2006.

c. ASTM C 1015-02 – Standard Practice for Installation of Cellulosic and Mineral Fiber Loose-Fill Thermal Insulation; 2006.
d. ASTM C 1374-03 – Standard Test Method for Determination of Installed Thickness of Pneumatically Applied Loose-Fill Building Insulation.
e. ASTM C 1574-04 – Standard Guide for Determining Blown Density of Pneumatically Applied Loose-Fill Mineral Fiber Thermal Insulation.
f. NAIMA – Recommendations for Installation in Residential and Other Light-Frame Construction – Fiber Glass Loose Fill Insulation (PUB #B1403).

1.4 SUBMITTALS

A. Submit under the provisions of Section 013300 – Submittal Procedures.
B. Submit the manufacturer's certificate under provisions of Section 014000 – Quality Requirements that products meet or exceed specified requirements.
C. Submit all requests for substitutions under provisions of Section 012500 – Substitution Procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with the manufacturer's product data for handling and storage.
B. Delivery of materials to the site shall be coordinated with the designated construction schedule to minimize the amount of time the materials are stored on site prior to installation. Materials shall not be delivered more than two days prior to being installed.
C. Materials being stored on site shall be protected from exposure to the natural elements. Any material being stored outside of the building enclosure shall be placed on blocking to keep it elevated from sitting in direct contact with the ground and covered with a waterproof, breathable covering such as a canvas tarpaulin to prevent exposure to moisture.
D. Materials that have been damaged upon receipt at the site or exposed to moisture shall be brought to the attention of the site supervisor, removed from the site, and replaced with suitable materials.
E. On-site handling of insulation shall be conducted in compliance with the manufacturer's recommended procedures.

1.6 QUALITY ASSURANCE

A. Retain ASTM test method below for each product in Part 2. Provide insulation and related materials with the fire-test-response characteristics required by building codes and regulations, as determined by testing identical products per ASTM E 84 for surface-burning characteristics and other methods indicated with product, by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
   1. Surface burning characteristics: ASTM E 84.
   2. Fire-resistance ratings: ASTM E 119.
   3. Combustion characteristics: ASTM E 136.

1.7 QUALITY CONTROL

A. Provide certification that insulation has been installed per the requirements of this section and the plan and code listing value. Certification shall be signed by the principal of the insulation Subcontractor and the General Contractor.

1.8 WARRANTY

A. Provide the manufacturer's standard commercial warranty for a period of at least 10 years from the date of manufacture printed on the product. The manufacturer

guarantees the actual thermal resistance of the insulation will not vary by more than 10% from its published aged R-value.

1.9 INTENDED PERFORMANCE

A. Building insulation is a critical component in controlling heat flow out of a building when temperature conditions are warmer inside than outside, and into a building when temperature conditions are warmer outside than inside. *[**Note to the Building Designer/Architect** – In existing houses the addition of insulation into exterior wall and band joist cavities will affect the drying potential of the assembly. Prior to the application of insulation, wood and masonry materials could dry easily because there is no insulation impeding the movement of heat flow. The new drying potential of the wall assembly must be considered so that moisture does not become trapped, leading to assembly component deterioration. This means that all moisture and bulk water penetration mechanisms into the assembly must be successfully managed (with the use of flashing, vapor retarders, capillary breaks, etc.) so that bulk water does not enter the assembly and water vapor flow is controlled.]* Several important benefits are associated with adequate levels of correctly installed building insulation: energy is saved, and the cost of operating a house is reduced; the space conditioning system operates more efficiently and effectively, and occupant thermal comfort is increased because interior temperatures are more consistently near desired levels; and enclosure surface temperatures are controlled, reducing the risk of cold-weather condensation occurring on building materials. *[**Note to the Building Designer/Architect –** Vapor retarders are a critical component of moisture control within building assemblies. Specifying and placement of them within the building assembly will vary, based on regional and climatic conditions. Heat flows from warm to cool areas, and, in general, the vapor retarder should be placed on the predominantly warm side of the assembly to prevent moisture from migrating, with the heat flow, to the cold side of the assembly where it could reach its dew point and condense.]* Building insulation must be kept dry from exterior and interior moisture sources and installed with no gaps, voids, or compression to achieve its rated insulating value. Furthermore, insulation materials such as blown insulation products may contribute to improved building envelope air tightness.

B. The home owner should be advised that the relative humidity within the living area should be kept at or below 40% R.H. when outside temperatures fall below 32° F.

2. PART 2 PRODUCTS

2.1 BLOWN INSULATION MATERIALS FOR NEW AND EXISTING HOUSING

A. Blown Insulation

1. Manufacturers:
   a. Green Fiber; GreenFiber All Borate Stabilized Wall Spray Insulation. www.greenfiber.com.
   b. Johns Manville Corporation; Spider Insulation (with or without netting). www.jm.com.
   c. Nu-Wool Company, Inc.; Nu-Wool WALLSEAL Insulation. www.nuwool.com
2. Thickness: As specified on plans. Must meet all jurisdictional requirements and energy calculations.
3. Existing Housing Application: Existing walls can receive a dry dense pack application with cellulose and glass fiber based products using a drill and fill method.

3. PART 3 EXECUTION

3.1 INSPECTION

A. Verify substrate conditions under provisions of Section 013100 – Project Management and Coordination.
B. Verify that surfaces are clean, dry, and free of matter that may inhibit insulation installation.
C. Verify that the areas to be insulated are dry and do not exhibit any moisture or signs of moisture intrusion. Moisture intrusion conditions found must be corrected.
D. Verify the moisture content of the framing/sheathing prior to insulating, and ensure that the levels are below 15%.
E. Verify that other work on and within spaces to be insulated is complete prior to insulation application.
F. Notify the Owner's Representative of any existing conditions that will adversely affect execution. Beginning installation means acceptance of substrate and project conditions.
G. Existing housing applications require thorough assessment of existing services and materials, where possible, in locations to receive insulation.

3.2 INSTALLATION

A. General
1. Comply with the manufacturer's product installation information for each type and for the conditions encountered.
2. Installers require protective equipment as per the manufacturer's specifications.
3. All insulation must achieve RESNET-defined Grade 1 installation.
4. Keep all insulation at least 3 inches away from combustible sources such as chimneys, non-Insulation Contact lighting fixtures, and heated flue pipes. Insulation can be in contact with only materials and services that are rated for insulation contact.

B. Existing Housing Considerations
1. The National Electric Code forbids the installation of blown-in insulation that envelops the conductors of knob and tube wiring.
2. Remove existing insulation if it impedes air sealing and insulation placement efforts in the application area.

C. Thermal Insulation Installation
1. Damp Blown Insulation
a. Install in indicated exterior walls and ceiling areas.
b. Apply in sufficient thickness and density to achieve the specified performance.
c. The moisture content of spray applied insulation must meet the manufacturer requirements before being enclosed with drywall or similar sheathing.
d. Certain sprayed insulations may be installed in existing wall cavities as designated by the manufacturer and subject to product manufacturer requirements.
e. Blown-in cellulose should be installed to a density between 3.0 to 3.5 pcf in walls to prevent settling.
f. Blown-in fiberglass should be installed to a density between 1.8 to 2.3 pcf in walls to prevent settling.

3.3 COMMISSIONING/TESTING/VERIFICATION

A. General

1. Comply with the verification, testing, and commissioning requirements of the national and/or regional certification programs outlined:
   a. U.S. Environmental Protection Agency Energy Star for Homes Version 3 – Thermal Enclosure System Rater Checklist
   b. NAIMA 25 Checkpoints for Inspecting Insulation Jobs (BI497)
   c. U.S. Green Building Council LEED for Homes (January 2008) – Durability Inspection Checklist

Appendix H: Section 07 21 26 Thermal Insulation Dry Blown Insulation

Note: The application of this component specification assumes that the architect and building designer are familiar with the building science concepts relating to building system component interactions (e.g., moisture, condensation, and thermal profiles through building assemblies) and the implications associated with specifying particular materials for use. Not all components contained in these specifications are applicable for use in all building systems. It is the responsibility of the building designer and/or architect to select a component that is suitable for each particular building design. This specification is not intended to supersede local, state, or federal codes. This specification assumes that the installer possesses a good working knowledge of the applicable codes and regulations, safety practices, and methods necessary for proper installation. It also assumes that the installer understands the fundamentals of residential construction that affect the installation of insulation materials.

1. PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 – General Requirements, and the Drawings are collectively applicable to this Section.
B. Section 06 10 00: Rough Carpentry
C. Section 07 21 29: Sprayed Insulation
D. Section 07 24 00: Exterior Insulation and Finishing Systems
E. Section 07 26 13: Above-Grade Vapor Retarders
F. Section 07 27 00: Air Barriers

1.2 SECTION INCLUDES

A. Fibrous insulation products pneumatically blown dry into exterior wall cavities:
   1. Blown-in fiberglass
   2. Blown-in cellulose

1.3 COMPONENT DESCRIPTION

*[**Note to the Building Designer/Architect** – Blown insulation is not recommended for use in sidewalls below grade or for filling cavities of masonry walls. The Designer/Architect should be familiar with and refer to the appropriate sections of the National Electric Codes, ASTM standards, CIMA Technical Bulletins, and International Residential Code (IRC)/Interinational Building Code (IBC) for more information.]*

A. Standards: Performance of the system is designed to meet or exceed the Reference Standards specified:
   1. American Society for Testing and Materials (ASTM)
   2. Federal Specifications (Fed. Spec.)
   3. The Cellulose Insulation Manufacturers Association (CIMA)
   4. Underwriters' Laboratories, Inc. (UL)
   5. The North American Insulation Manufacturers Association (NAIMA)
   6. Blown Insulation
      a. ASTM C 739-03e1 – Standard Specification for Cellulosic Fiber Loose-Fill Thermal Insulation; 2005b.
      b. ASTM C 764-04 – Standard Specification for Mineral Fiber Loose-fill Insulation.

c. ASTM C 1015-02 – Standard Practice for Installation of Cellulosic and Mineral Fiber Loose-Fill Thermal Insulation; 2006.
d. ASTM C 1374-03 – Standard Test Method for Determination of Installed Thickness of Pneumatically Applied Loose-Fill Building Insulation.
e. ASTM C 1574-04 – Standard Guide for Determining Blown Density of Pneumatically Applied Loose-Fill Mineral Fiber Thermal Insulation.
f. NAIMA – Recommendations for Installation in Residential and Other Light-Frame Construction – Fiber Glass Loose Fill Insulation (PUB #B1403).

1.4 SUBMITTALS

A. Submit under the provisions of Section 013300 – Submittal Procedures.
B. Submit the manufacturer's certificate under provisions of Section 014000 – Quality Requirements that products meet or exceed specified requirements.
C. Submit all requests for substitutions under provisions of Section 012500 – Substitution Procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with the manufacturer's product data for handling and storage.
B. Delivery of materials to the site shall be coordinated with the designated construction schedule to minimize the amount of time the materials are stored on site prior to installation. Materials shall not be delivered more than two days prior to being installed.
C. Materials being stored on site shall be protected from exposure to the natural elements. Any material being stored outside of the building enclosure shall be placed on blocking to keep it elevated from sitting in direct contact with the ground and covered with a waterproof, breathable covering such as a canvas tarpaulin to prevent exposure to moisture.
D. Materials that have been damaged upon receipt at the site or exposed to moisture shall be brought to the attention of the site supervisor, removed from the site, and replaced with suitable materials.
E. On-site handling of insulation shall be conducted in compliance with the manufacturer's recommended procedures.

1.6 QUALITY ASSURANCE

A. Retain ASTM test method below for each product in Part 2. Provide insulation and related materials with the fire-test-response characteristics required by building codes and regulations, as determined by testing identical products per ASTM E 84 for surface-burning characteristics and other methods indicated with product, by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
   1. Surface burning characteristics: ASTM E 84.
   2. Fire-resistance ratings: ASTM E 119.
   3. Combustion characteristics: ASTM E 136.

1.7 QUALITY CONTROL

A. Provide certification that insulation has been installed per the requirements of this section and the plan and code listing value. Certification shall be signed by the principal of the insulation Subcontractor and the General Contractor.

1.8 WARRANTY

A. Provide the manufacturer's standard commercial warranty for a period of at least 10 years from the date of manufacture printed on the product. The manufacturer

guarantees the actual thermal resistance of the insulation will not vary by more than 10% from its published aged R-value.

1.9 INTENDED PERFORMANCE

A. Building insulation is a critical component in controlling heat flow out of a building when temperature conditions are warmer inside than outside, and into a building when temperature conditions are warmer outside than inside. *[**Note to the Building Designer/Architect –** In existing houses the addition of insulation into exterior wall and band joist cavities will affect the drying potential of the assembly. Prior to the application of insulation, wood and masonry materials could dry easily because there is no insulation impeding the movement of heat flow. The new drying potential of the wall assembly must be considered so that moisture does not become trapped, leading to assembly component deterioration. This means that all moisture and bulk water penetration mechanisms into the assembly must be successfully managed (with the use of flashing, vapor retarders, capillary breaks, etc.) so that bulk water does not enter the assembly and water vapor flow is controlled.]* Several important benefits are associated with adequate levels of correctly installed building insulation: energy is saved, and the cost of operating a house is reduced; the space conditioning system operates more efficiently and effectively, and occupant thermal comfort is increased because interior temperatures are more consistently near desired levels; and enclosure surface temperatures are controlled, reducing the risk of cold-weather condensation occurring on building materials. *[**Note to the Building Designer/Architect –** Vapor retarders are a critical component of moisture control within building assemblies. Specification and placement of them within the building assembly will vary, based on regional and climatic conditions. Heat flows from warm to cool areas, and, in general, the vapor retarder should be placed on the predominantly warm side of the assembly to prevent moisture from migrating, with the heat flow, to the cold side of the assembly where it could reach its dew point and condense.]* Building insulation must be kept dry from exterior and interior moisture sources and installed with no gaps, voids, or compression to achieve its rated insulating value. Furthermore, insulation materials such as blown insulation products may contribute to improved building envelope air tightness.

B. The home owner should be advised that the relative humidity within the living area should be kept at or below 40% R.H. when outside temperatures fall below 32°F.

2. PART 2 PRODUCTS

2.1 BLOWN INSULATION MATERIALS FOR NEW AND EXISTING HOUSING

A. Blown Insulation

1. Manufacturers:
   a. CertainTeed Corporation; OPTIMA Fiber Glass fiber composition with fabric netting. www.certainteed.com
   b. Green Fiber; GreenFiber All Borate Retrofit Wall Insulation, All Borate Loose Fill Attic and Wall Insulation. www.greenfiber.com.
   c. Johns Manville Corporation; JM Spider For Drill and Fill. www.jm.com.
   d. Owens Corning Corporation; PROPINK blown-in insulation with netting. www.owenscorning.com
2. Thickness: As specified on plans. Must meet all jurisdictional requirements and energy calculations.

3. Existing Housing Application: Existing walls can receive a dry dense pack application with cellulose and glass fiber based products using a drill and fill method.

3. PART 3 EXECUTION

3.1 INSPECTION

A. Verify substrate conditions under provisions of Section 013100 – Project Management and Coordination.
B. Verify that surfaces are clean, dry, and free of matter that may inhibit insulation installation.
C. Verify that the areas to be insulated are dry and do not exhibit any moisture or signs of moisture intrusion. Moisture intrusion conditions found must be corrected.
D. Verify the moisture content of the framing/sheathing prior to insulating, and ensure that the levels are below 15%.
E. Verify that other work on and within spaces to be insulated is complete prior to insulation application.
F. Notify the Owner's Representative of any existing conditions that will adversely affect execution. Beginning installation means acceptance of substrate and project conditions.
G. Existing housing applications require thorough assessment of existing services and materials, where possible, in locations to receive insulation.

3.2 INSTALLATION

A. General
1. Comply with the manufacturer's product installation information for each type and for the conditions encountered.
2. Installers require protective equipment as per the manufacturer's specifications.
3. All insulation must achieve RESNET-defined Grade 1 installation.
4. Keep all insulation at least 3 inches away from combustible sources such as chimneys, non-Insulation Contact lighting fixtures, and heated flue pipes. Insulation can be in contact with only materials and services that are rated for insulation contact.

B. Existing Housing Considerations
1. The National Electric Code forbids the installation of blown-in insulation that envelops the conductors of knob and tube wiring.
2. Remove existing insulation if it impedes air sealing and insulation placement efforts in the application area.

C. Thermal Insulation Installation
1. Dry-Blown Insulation
a. Install in indicated exterior walls and ceiling areas.
b. Apply in sufficient thickness and density to achieve the specified performance.
c. Various types of permanent retainer systems are used to install dry fibrous insulation; most systems are proprietary, and the manufacturers provide detailed instructions and often special training programs for their use.
d. Blown-in cellulose should be installed to a density between 3.0 to 3.5 pcf in walls to prevent settling.
e. Blown-in fiberglass should be installed to a density between 1.8 to 2.3 pcf in walls to prevent settling.

3.3 COMMISSIONING/TESTING/VERIFICATION

A. General

1. Comply with the verification, testing, and commissioning requirements of the national and/or regional certification programs outlined:
   a. U.S. Environmental Protection Agency Energy Star for Homes Version 3 – Thermal Enclosure System Rater Checklist
   b. NAIMA 25 Checkpoints for Inspecting Insulation Jobs (BI497)
   c. U.S. Green Building Council LEED for Homes (January 2008) – Durability Inspection Checklist

Appendix I: Section 07 25 00 Weather Barriers Drainage Plane

Note: The application of this component specification assumes that the architect and building designer are familiar with the building science concepts relating to building system component interactions (e.g., moisture, condensation, and thermal profiles through building assemblies) and the implications associated with specifying particular materials for use. Not all components contained in these specifications are applicable for use in all building systems. It is the responsibility of the building designer and/or architect to select a component that is suitable for each particular building design. This specification is not intended to supersede local, state, or federal codes. This specification assumes that the installer possesses a good working knowledge of the applicable codes and regulations, safety practices, and methods necessary for proper installation. It also assumes that the installer understands the fundamentals of residential construction that affect the installation of drainage plane materials.

1. PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 – General Requirements, and the Drawings are collectively applicable to this Section.
B. Section 06 10 00: Rough Carpentry
C. Section 07 00 00: Thermal and Moisture Protection
D. Section 07 24 00: Exterior Insulation and Finishing System
E. Section 07 26 13: Above-Grade Vapor Retarders
F. Section 07 27 00: Air Barriers
G. Section 07 46 00: Siding
H. Section 07 92 01: Air Sealing

1.2 SECTION INCLUDES

A. Housewrap
   1. Non-woven, non-perforated polyolefin-based membrane
B. Fasteners
   1. Plastic cap nails or wide crown staples *[**Note to the Building Designer/Architect** – Wide crown staples or button cap nails firmly attach housewrap to the wall and reduce the risk of wind tear off.]*
C. Construction Tape
   1. Oriented polypropylene ultraviolet (UV) treated film with acrylic adhesive
D. Flashing Tape
   1. High-density polyethylene (HDPE) film facer with a butyl rubber adhesive and polymeric-coated paper release liner

1.3 COMPONENT DESCRIPTION

A. Standards: Performance of the component is designed to meet or exceed the Reference Standards and Resources specified:
   1. American Society for Testing and Materials (ASTM)
   2. Canadian Construction Materials Centre (CCMC)
   3. Housewrap
      a. Air Leakage (CCMC Technical Guide 07273): [0.02 L/s-m^2 minimum] @ 75 Pa. *[**Note to the Building Designer/Architect** – Housewrap protects against air infiltration, reducing energy use and increasing comfort.]*

b. Water Vapor Permeance (ASTM E 96): 286 ng/Pas m^2 [5 perms] minimum *[**Note to the Building Designer/Architect** – Engineered water vapor permeability enables water vapor behind the housewrap to escape to the exterior.]*
c. Tensile Strength (ASTM D 882): 4.5 N / 25 mm minimum *[**Note to the Building Designer/Architect** – The non-woven, non-perforated polyolefin-based membrane offers tear resistance and durability.]*

4. Construction Tape
   a. Typical Adhesion, ASTM D 3330. Stainless Steel 75 oz per inch
   b. Tensile Strength, ASTM D 882, 20 lb/in., mi
5. Flashing Tape
   a. Water Vapor Permeance, ASTM E 96, <1 perm.
   b. Thickness, ASTM D 3767, Method A, 20 mil

1.4 SUBMITTALS

A. Submit under the provisions of Section 013300 – Submittal Procedures.
B. Submit the manufacturer's certificate under provisions of Section 014000 – Quality Requirements that products meet or exceed specified requirements.
C. Submit all requests for substitutions under provisions of Section 012500 – Substitution Procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with the manufacturer's product data for handling and storage.
B. Delivery of materials to the site shall be coordinated with the designated construction schedule to minimize the amount of time the materials are stored on site prior to installation. Materials shall not be delivered more than two days prior to being installed.
C. Materials being stored on site shall be protected from exposure to the natural elements. Any material being stored outside of the building enclosure shall be placed on blocking to keep it elevated from sitting in direct contact with the ground and covered with a waterproof, breathable covering such as a canvas tarpaulin to prevent exposure to moisture. *[**Note to the Building Designer/Architect** – Housewrap should not be exposed to sunlight for more than 120 days.]*
D. Materials that have been damaged upon receipt at the site or exposed to moisture shall be brought to the attention of the site supervisor, removed from the site, and replaced with suitable materials.

1.6 QUALITY CONTROL

A. Provide certification that a weather-resistant barrier has been installed per the requirements of this section and the plan and code listing value. Certification shall be signed by the principal of the drainage plane Subcontractor and the General Contractor.

1.7 WARRANTY

A. Provide the manufacturer's standard commercial warranty for a period of 10 years from the date of manufacture printed on the product.

1.8 INTENDED PERFORMANCE

A. Exterior finishes cannot be relied on to fully protect the structure from bulk water damage. Stucco or brick are porous and will absorb water, while gaps in siding can allow water to enter the wall assembly. The drainage plane protects the building structure from getting wet and prevents both bulk water intrusion in the building assembly and moisture buildup in exterior wall cavities, which can ultimately lead to

mold and mildew growth and eventually rot and failure of the building structure. Every home needs a properly installed drainage plane to protect the structure.

The drainage plane is a layer of water-resistant material that covers the home behind the exterior finish. A complete and continuous drainage plane is integrated with the windows, doors, and mechanical penetrations in the building. Components of the drainage plane overlap each other shingle style so that water drains down the wall without becoming trapped. Water that penetrates the exterior finish is moved down the drainage plane by gravity to an exit point at the bottom of the wall assembly. Space between the cladding and the drainage plane along with a low exit point are critical to the performance of the system.

The material properties of the drainage plane must both shed bulk water from the exterior and must allow water vapor from the interior to pass through to the exterior. Properly installed, the weather-resistant barrier also can be part of the air sealing program.

2. PART 2 PRODUCTS

2.1 HOUSEWRAP

A. Non-woven, non-perforated polyolefin-based membrane

1. Manufacturers:
   a. Dow Chemical Company; WEATHERMATE Plus. http:building.dow.com
   b. DuPont Building Innovations; DuPont Tyvek HomeWrap. www2.dupont.com/Residential_Construction/en_US
2. Width: 9 ft (2744 mm) or 9-1/2 ft (2896 mm) wide rolls.

2.2 FASTENERS

A. Plastic cap nails or wide crown staples.

1. Manufacturers:
   a. Grip Rite. http:www.grip-rite.com
   b. DuPont Building Innovations; DuPont Tyvek Wrap Caps. www2.dupont.com/Residential_Construction/en_US
2. Size: 1-inch head plastic cap nail or 15/16-wide crown staples

2.3 CONSTRUCTION TAPE

A. Oriented polypropylene ultraviolet (UV) treated film with acrylic adhesive.

1. Manufacturers:
   a. Dow Chemical Company; WEATHERMATE construction tape. http:building.dow.com
   b. DuPont Building Innovations; DuPont Tyvek Tape. www2.dupont.com/Residential_Construction/en_US
2. Width: 3 inches

2.4 FLASHING

A. High-density polyethylene (HDPE) film facer with a butyl rubber adhesive and polymeric-coated paper release liner.

1. Manufacturers:
   a. Dow Chemical Company; WEATHERMATE Straight Flashing, Sill Pan, Flexible Flashing. http:building.dow.com
   b. DuPont Building Innovations; DuPont StraightFlash, FlexWrap. www2.dupont.com/Residential_Construction/en_US
2. Width: 4-inch minimum

3. PART 3 EXECUTION

3.1 INSPECTION

A. Verify substrate conditions under provisions of Section 013100 – Project Management and Coordination.

B. Verify that substrates and surfaces to which the drainage plane will be applied are clean, dry, and free of matter that may damage housewrap. *[**Note to the Building Designer/Architect** – Protruding nails or other sharp metal can penetrate the housewrap and defeat its purpose.]*

C. Verify that other work on spaces to be covered by the drainage plane is complete prior to the drainage plane application.

D. Notify the Owner's Representative of any existing conditions that will adversely affect execution. Beginning installation means acceptance of substrate and project conditions.

E. Any defects or damages found in the exterior sheathing prior to installation shall be repaired and/or replaced.

3.2 INSTALLATION

A. General

1. Comply with the manufacturer's product installation information for the conditions encountered.
2. Installers require protective equipment as per the manufacturer's specifications.

B. Drainage Plane Installation

1. Housewrap
   a. Housewrap should always be installed on or against dry, clean materials and surfaces to ensure performance to the intended design life of the building system.
   b. Housewrap should be installed horizontally with the print side facing outward. *[**Note to the Building Designer/Architect –** Correct orientation is critical due to the engineered vapor permeability.]*
   c. Position the joints or laps of sheets over studs or other firm bearing to achieve an effective and permanent seal.
   d. Overlap vertical seams a minimum of 6 inches to shed water away from the building assembly, and seal with construction tape. *[**Note to the Building Designer/Architect –** All vertical seams must be taped for weather resistance performance. Horizontal seams need to be taped only if the housewrap is being used as the air barrier strategy.]*
   e. Position the bottom edge of the housewrap to overlap the foundation 1 inch.
   f. Inside and outside corners should overlap 16 inches minimum.
   g. Taping of all housewrap joints is required if housewrap is intended to be used as an air barrier.
   h. Fastening of housewrap shall be in accordance with the manufacturer's installation recommendations, local and regional codes, and as specified in the fastening schedule on the plans.
   i. All window, door, and mechanical openings must be flashed per window/door/penetration flashing instructions and integrated into the drainage plane.

3.3 COMMISSIONING/TESTING/VERIFICATION

A. General

1. Comply with the verification, testing, and commissioning requirements of the national and/or regional certification programs outlined:
   a. U.S. Environmental Protection Agency Energy Star for Homes Version 3 – Thermal Enclosure System Rater Checklist
   b. U.S. Green Building Council LEED for Homes (January 2008) – Durability Inspection Checklist

Appendix J: Section 08 53 13 Vinyl Windows

Note: The application of this component specification assumes that the architect and building designer are familiar with the building science concepts relating to building system component interactions (e.g., moisture, condensation, and thermal profiles through building assemblies) and the implications associated with specifying particular materials for use. Not all components contained in these specifications are applicable for use in all building systems. It is the responsibility of the building designer and/or architect to select a component that is suitable for each particular building design. This specification is not intended to supersede local, state, or federal codes. This specification assumes that the installer possesses a good working knowledge of the applicable codes and regulations, safety practices, and methods necessary for proper installation.

1. PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Section 06 10 00: Rough Carpentry
B. Section 07 25 00: Weather Barriers Drainage Plane
C. Section 07 92 00: Sealants and Caulking
D. Section 23 30 00: HVAC Air Distribution
E. Section 23 54 16.15: Gas-Fired Furnaces
F. Section 23 63 13: Air-Cooled Refrigerant Condensers

1.2 SECTION INCLUDES

A. Factory fabricated tubular extruded vinyl windows with fixed glazing.

1.3 SYSTEM DESCRIPTION

A. Standards: Testing standards for structural performance, air infiltration, and water penetration to meet or exceed those specified in ANSI/AAMA/NWWDA 101/I.S.2-97 for the type of window unit indicated. Provide vinyl windows bearing the AAMA label certifying compliance with ANSI/AAMA/NWWDA 101/I.S.2-97 for the type of window unit indicated.
B. References:
   1. AAMA 502 – Voluntary Specification for Field Testing of Windows and Sliding Doors.
   2. AAMA 613 – Voluntary Performance Requirements and Test Procedures for Organic Coatings on Plastic Profiles.
   3. ASTM C 1036 – Flat Glass.
   4. ASTM C 1048 – Heat-Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated Glass.
   5. ASTM D 3656 – Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns.
   6. ASTM E 283 – Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Difference Across the Specimen.
   7. ASTM E 547 – Water Penetration of Exterior Windows, Curtain Walls, and Doors by Cyclic Static Air Pressure Differential.
   8. SMA 1201 – Specifications for Insect Screens for Windows, Sliding Doors and Swinging Doors.

C. Testing: Provide test reports from an independent testing laboratory certifying performance of window units for the following tests complying with the requirements in ANSI/AAMA/NWWDA 101/I.S.2-97:
   1. Structural performance under wind loading
   2. Resistance to air leakage
   3. Resistance to water penetration
   4. Forced entry resistance

1.4 SUBMITTALS

A. Submit under the provisions of Section 013300 – Submittal Procedures.
B. Submit the manufacturer's certificate under provisions of Section 014000 – Quality Requirements that products meet or exceed specified requirements.
C. Submit all requests for substitutions under provisions of Section 012500 – Substitution Procedures.
D. Product Data
   1. Manufacturer's published product data.
   2. Test reports demonstrating compliance with air infiltration, water resistance, and structural performance requirements.
E. Shop Drawings showing elevations and details of each type of unit.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with the manufacturer's product data for handling and storage.
B. Delivery of materials to the site shall be coordinated with the designated construction schedule to minimize the amount of time the materials are stored on site prior to installation. Materials shall not be delivered more than two days prior to being installed.
C. Materials being stored on site shall be protected from exposure to the natural elements. Any material being stored outside of the building enclosure shall be placed on blocking to keep it elevated from sitting in direct contact with the ground and covered with a waterproof, breathable covering such as a canvas tarpaulin to prevent exposure to moisture.
D. Materials that have been damaged upon receipt at the site or exposed to moisture shall be brought to the attention of the site supervisor, removed from the site, and replaced with suitable materials.

1.6 QUALITY CONTROL

A. Provide certification that a weather-resistant barrier has been installed per the requirements of this section and the plan and code listing value. Certification shall be signed by the principal of the drainage plane Subcontractor and the General Contractor.

1.7 WARRANTY

A. Provide the manufacturer's standard commercial warranty for a 10-year period from the date of the window purchase. The manufacturer guarantees it will repair or replace any window that is defective in materials or workmanship and will pay the costs of all parts and labor.
   1. Warranty period: 10 years from the date of completion.

1.8 INTENDED PERFORMANCE

A. Window performance is based on insulating properties (U-value) and the amount of solar heat that is allowed into the building. In areas where air conditioning will be used, low solar hear gain coefficient (SHGC) windows are recommended. Even in cold climates, low SHGC windows can cut the heat gain in living units and reduce

the need for the operation of central or unit air conditioners. Low SHGC windows will also reduce the installed size of central air conditioning equipment. Windows with low U-values and a low-e coating will enhance the comfort for the occupant and will enable compact centralized ducting strategies with high sidewall interior register placement.

2. PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Milgard. www.milgard.com
B. Jeld-Wen Windows & Doors. www.jeld-wen.com
C. Ply Gem Windows. www.plygemwindows.com
D. Substitutions: Submit in accordance with Section 012500 – Product Options & Substitutions.

2.2 MATERIALS

A. General: Comply with the requirements of ANSI/AAMA/NWWDA 101/I.S.2-97.
B. Vinyl: Windows shall be extruded, high impact resistant, rigid polyvinyl chloride (PVC). Color to be selected by the Owner's Representative
C. Construction: All corners of the frame and sash will be mitered and fusion welded. All welds are to be dressed and finished to match the surrounding frame area.
D. Thermal Performance: *[**Note to the Building Designer/Architect –** Windows are an important part of the thermal enclosure, and their thermal performance must be regionally appropriate to achieve energy efficiency and comfort objectives.]* The thermal performance of windows must be independently tested and certified in accordance with National Fenestration Rating Council (NFRC) procedures for U-Factor (NFRC 100) and Solar Heat Gain Coefficient (NFRC 200). The following criteria must be met:
    1. Solar Heat Gain Coefficient (SHGC): Meets ENERGY STAR SHGC Qualification Criteria for Residential Windows for the climate zone where the installation occurs. www.energystar.gov
    2. U-Factor: Meets ENERGY STAR U-Factor Qualification Criteria for Residential Windows for the climate zone where the installation occurs. www.energystar.gov
E. Weatherstripping: Provide double Ethelyne Propelyene Diene Monomer (EPDM) weatherstripping on all operating sash members. Weatherstripping shall be replaceable without the use of special tools or skills.
F. Glazing Stops: Provide screw-applied or snap-on glazing stops coordinated with glass sections indicated. Finish glazing stops shall match the exterior window finish.
G. Window Locks: Follow the specifications on the Drawings.
H. Screens: Follow the specifications on the Drawings.
I. Hardware: Follow specifications on the Drawings.
J. Fire-rated (1/2 hour), impact safety-rated glazing material. FireLite NT fire-rated or equal. See the Construction Documents for type and location.
K. Sound rated assemblies – Laminate or special thickness glazing with additional gasketing. See the Construction Documents for type and location.

2.3 FABRICATION

A. General: Fabricate units shall comply with ANSI/AAMA/NWWDA 101/I.S.2-97 and other indicated standards.
B. Fabrication: Pre-glaze units at the factory. All units are to be inside glazed to allow re-glazing from the inside without dismantling sash framing.

2.4 WATER MANAGEMENT

A. General: Effectively integrate the window with Section 072500 – Weather Barriers Drainage Plane to shed water. Follow the instructions shown on the Drawings. *[**Note to the Building Designer/Architect –** Windows are a penetration through the building enclosure, and therefore they could be an entry point for bulk water. Detailed step-by-step drawings showing how each window flashing component at the sill, jambs, and head integrates with the building drainage plane will uphold the durability of the building.]* Use where noted and applicable the following materials in the integration process.
    1. Housewrap: As part of the building drainage plan, it is installed over exterior sheathing to reduce air infiltration and bulk water intrusion. It requires integration with the flashing system.
    2. Construction Tape: Use over joints and seams of housewraps and insulated sheathing that is modified as part of the window installation process, as well as at penetrations, to supplement the building envelope resistance to moisture and air intrusion.
    3. Flashing: Install to provide a tear-resistant seal that resists bulk water intrusion in window rough opening windows.
A. Substitutions: Submit in accordance with Section 012500 – Product Options & Substitutions.

3. PART 3 EXECUTION

3.1 EXAMINATION

A. Verify substrate conditions under provisions of Section 013100 – Project Management and Coordination.
B. Verify wall openings and adjoining work are ready to receive work of this Section.
C. Beginning installation means acceptance of substrate and project conditions.
C. Notify the Owner's Representative of any existing conditions that will adversely affect execution.

3.2 INSTALLATION

A. General
    1. Comply with the manufacturer's product installation information for the conditions encountered.
    2. Installers require protective equipment as per the manufacturer's specifications.
B. Install units plumb, level, accurately aligned, and securely anchored in accordance with the manufacturer's instruction.
C. Install finish trim, flashings, and perimeter sealant as shown on the Drawings, and to maintain a weathertight installation.

3.3 COMPLETION

A. Adjusting
    1. Adjust hardware for smooth operation and to provide weathertight closure.
    2. Ensure that windows operate correctly, free from binding or other defects.

B. Cleaning
   1. Remove protective material from prefinished surfaces.
   2. Wash surfaces by the method recommended and acceptable to the window and sealant manufacturer; rinse and wipe surfaces clean prior to Substantial Completion.

3.4 COMMISSIONING/TESTING/VERIFICATION

A. General
   1. Comply with the verification, testing, and commissioning requirements of the national and/or regional certification programs outlined:
      a. U.S. Environmental Protection Agency Energy Star for Homes Version 3 – Thermal Enclosure System Rater Checklist
      b. U.S. Green Building Council LEED for Homes (January 2008) – Durability Inspection Checklist

Appendix K: Section 23 30 00 HVAC Air Distribution

Note: The application of this component specification assumes that the architect and building designer are familiar with the building science concepts relating to building system component interactions (e.g., moisture, condensation, and thermal profiles through building assemblies) and the implications associated with specifying particular materials for use. Not all components contained in these specifications are applicable for use in all building systems. It is the responsibility of the building designer and/or architect to select a component that is suitable for each particular building design. This specification is not intended to supersede local, state, or federal codes. This specification assumes that the installer possesses a good working knowledge of the applicable codes and regulations, safety practices, and methods necessary for proper installation.

1. PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 – General Requirements, and the Drawings are collectively applicable to this Section.
B. Section 06 10 00: Rough Carpentry
C. Section 23 40 00: HVAC Air Cleaning Devices
D. Section 23 54 16.13: Gas-Fired Furnaces
E. Section 23 63 13: Air-Cooled Refrigerant Condensers

1.2 SECTION INCLUDES

A. Installation of HVAC air distribution system.

1.3 COMPONENT DESCRIPTION

A. Standards: Performance of the system is designed to meet or exceed the Reference Standards specified:
   1. American Society for Testing and Materials (ASTM)
   2. Air Conditioning Contractors of America (ACCA)
   3. American Gas Association (AGA)
   4. Air Moving and Conditioning Association (AMCA)
   5. Air-Conditioning, Heating and Refrigeration Institute (AHRI)
   6. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
   7. American Society of Mechanical Engineers (ASME)
   8. American National Standards Institute (ANSI)
   9. CSA International
   10. Federal Specifications (Fed. Spec.)
   11. National Electrical Manufacturers Association (NEMA)
   12. National Fire Protection Association (NFPA)
   13. The North American Insulation Manufacturers Association (NAIMA)
   14. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
   15. Underwriters' Laboratories, Inc. (UL)
   16. Ductwork
      a. SMACNA – HVAC Duct Construction Standards – Metal and Flexible; 2005.
      b. SMACNA – Seismic Restraints Manual for Mechanical Systems; 2008.

17. Fibrous Glass Board
    a. NAIMA – Fibrous Glass Residential Duct Construction Standard

1.4 SUBMITTALS
- A. Submit under the provisions of Section 013300 – Submittal Procedures.
- B. Submit the manufacturer's certificate under provisions of Section 014000 – Quality Requirements that products meet or exceed specified requirements.
- C. Submit all requests for substitutions under provisions of Section 012500 – Substitution Procedures.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Comply with the manufacturer's product data for handling and storage.
- B. Delivery of materials to the site shall be coordinated with the designated construction schedule to minimize the amount of time the materials are stored on site prior to installation. Materials shall not be delivered more than two days prior to being installed.
- C. Materials being stored on site shall be protected from exposure to the natural elements. Any material being stored outside of the building enclosure shall be placed on blocking to keep it elevated from sitting in direct contact with the ground and covered with a waterproof, breathable covering such as a canvas tarpaulin to prevent exposure to moisture.
- D. Materials that have been damaged upon receipt at the site or exposed to moisture shall be brought to the attention of the site supervisor, removed from the site, and replaced with suitable materials.

1.6 QUALITY CONTROL
- A. Provide certification that the HVAC air distribution system has been installed per the requirements of this section and the plan and code listing value. *[**Note to the Building Designer/Architect** – Installation technicians who are certified according to NATE (North American Technician Excellence) are preferred. These technicians have passed specialized HVAC tests.]* Certification shall be signed by the principal of the HVAC Subcontractor and the General Contractor.

1.7 WARRANTY
- A. Provide the manufacturer's standard commercial warranty from the date of substantial completion.

1.8 INTENDED PERFORMANCE
- A. The HVAC distribution system is intended to deliver air from the furnace or air conditioner to the room at the required temperature, volume, and velocity. The system should be sealed and tested for air tightness and tested for airflow at each register. The system should allow for the free passage of the conditioned air, with a minimum of elbows and turns.

2. PART 2 PRODUCTS

2.1 MANUFACTURERS:
- A. Low Velocity Round Flexible Ductwork: JP Lamborn Co., Flexmaster U.S.A., Inc., Hart & Cooley, Inc., Thermo-Flex.
- B. Fibrous Glass Board: CertainTeed, Owens Corning, Johns Manville, Knauf Insulation.
- C. Duct Mastic: Minnesota Mining and Manufacturing Duct Sealer 800, Tuff-Bond No. 12, Glen Coat Seal-Flex, RCD Corporation #6, McGill AirSeal UNI-MASTIC 181.
- D. Duct Fiber Tape: Hardcast Inc., United McGill Uni-Cast.

E. Grilles, Registers, and Diffusers: Air-O, Hart & Cooley, J & J, Kruger, Barber-Colman Anemostat, Price, Titus.
F. Substitutions: Submit in accordance with Section 01630 – Product Options & Substitutions.

2.2 MATERIALS

A. Ductwork: *[**Note to the Building Designer/Architect –** Ductwork should be located in conditioned space so that the efficiency of the HVAC air distribution system is optimized. Ductwork located in vented and unconditioned attics and crawlspaces is subject to temperature and humidity extremes that can be transferred to the air traveling through the ductwork, particularly if the ductwork is leaky. Return air ductwork is particularly susceptible to drawing uncomfortable outdoor air if the ductwork contains air leakage points and is located in unconditioned space. For example, the drawing of humid and hot outdoor air through return air ducts in an unconditioned attic will increase the temperature and humidity of return air that enters the air handling unit, making the air conditioner work harder (and use more energy) to condition the air to the desired temperature and humidity levels.]*
   1. General: All ductwork materials shall have fire and smoke hazard ratings as tested under ASTM E 84 and UL 181 not exceeding a flame spread of 25 and smoke developed of 50.
   2. Low Velocity Rectangular Metal Ductwork: Metal ductwork shall be galvanized sheet steel, ASTM A 527. Gauges and weights shall be per SMACNA and NFPA.
   3. Low Velocity Round Flexible Ductwork: Insulated-Duct UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation (per code requirement); polyethylene or aluminized barrier film. Thermal performance as noted in drawings. *[**Note to the Building Designer/Architect –** If the only alternative is for ductwork to travel through unconditioned space, then the ductwork needs to be insulated. Air in insulated ductwork is able to remain at the same temperature during its journey (provided the ductwork is not leaky), thereby making the HVAC distribution system efficient.]* Seamless vapor barrier jacket. Duct shall comply with UL 181 and NFPA 90A and B. Duct shall be capable of continuous operation at 1.5 inches of water static pressure and 4000 ft/min air velocity.
   4. Fibrous Glass Board: Insulated-Duct UL 181, Class 1. Rigid, resin bonded fibrous glass board.
B. Duct Mastic: Shall be water-based and comply with UL 181.
C. Duct Joints: Joints and seams as designated by SMACNA or shown on the Drawings.
D. Duct Fiber Tape: Mineral impregnated fiber tape and plastic activator-adhesive that complies with UL 181.
E. Grilles, Registers, and Diffusers: Refer to the Drawings for the list of grilles, registers, and diffusers. All surface mounted grilles shall have a perimeter gasket and flanged edge. All grilles shall have frames suitable for mounting in the surfaces designated by the architectural drawings; coordinate prior to ordering.
F. Other: Zone Dampers; Adhesives; Turning Vanes; Connectors; Fire Dampers; Ductwork Support; Ductwork Insulation. Shall be compatible with other elements of the air distribution system.

3. PART 3 EXECUTION

3.1 INSPECTION

A. Verify existing conditions under provisions of Section 013100 – Project Management and Coordination.

B. The HVAC Contractor shall examine the site, compare it with the plans and specifications, and shall have satisfied himself as to the conditions under which the work is to be performed. No allowance shall subsequently be made in his behalf for any extra expense to which he may be put due to failure or neglect on his part to make such an examination.

C. Notify the Owner's Representative of any existing conditions that will adversely affect execution. Beginning of execution will constitute acceptance of existing conditions.

3.2 INSTALLATION

A. General

1. Unless otherwise noted, all ductwork shall be constructed and installed in accordance with current SMACNA HVAC Duct Construction Standards – Metal and Flexible and NAIMA Fibrous Glass Residential Duct Construction Standard and NFPA Standards, Bulletin 90A. Ductwork and accessories shall be installed in a manner to prevent vibration and rattling.
2. Unless otherwise noted, all grilles, registers, diffusers, and duct fittings shall be installed in accordance with current SMACNA HVAC Duct Construction Standards. Terminals and fittings shall be installed in accordance with their State Fire Marshal approval and the manufacturer's recommendations.
3. All ductwork, grills, registers, diffusers, duct fittings, and the connections between these respective components (i.e., the entire HVAC air distribution system) shall be made as airtight as possible, using appropriate products as noted in the Drawings, to achieve duct leakage testing requirements noted in Section 3.3.A.1.a.
4. Comply with the manufacturer's product installation instructions and information.
5. Drawings accompanying these specifications, except where dimensions are shown, are diagrammatic and are not to be scaled. Drawings indicate generally the location of the equipment, duct, and piping, and while these are to be followed as closely as possible, all dimensions shall be checked at the site. Coordinate as necessary to conform to the building constructed and to fit the work of other trades.
6. All apparatus, ductwork, piping, and equipment shall fit into the available spaces in the building and must be introduced into the building at such time and in such manner as to cause no damage to the structure or finish.

B. Air Balancing: Provide services necessary to initially deliver the air quantities shown on the plans and finally balance for uniform temperature in the spaces served. Adjust all elements in grilles and diffusers for proper air distribution and to minimize drafts in the occupied zone of all rooms. Submit a final air balance report for approval to the Contractor. Comply with the SMACNA manual for the balancing and adjustment of air distributing systems.

3.3 COMMISSIONING/TESTING/VERIFICATION

A. General

1. Comply with the verification, testing, and commissioning requirements of the national and/or regional certification programs outlined:
   a. U.S. Environmental Protection Agency Energy Star for Homes Version 3 – HVAC System Quality Installation Contractor Checklist; HVAC System Quality Installation Rater Checklist. Total duct leakage shall be ≤ 6 cubic feet per minute (at 25 Pa test pressure) per 100 square feet of conditioned floor area. Duct leakage to outside shall be ≤ 4 cubic feet per minute (at 25 Pa test pressure) per 100 square feet of conditioned floor area. *[**Note to the Building Designer/Architect –** An HVAC air distribution system that achieves this level of airtightness, by virtue of on-site testing, is considered to be airtight and energy efficient.]*
   b. ACCA Standard 5 HVAC Quality Installation Specifications (ANSI/ACCA 5 QI- 2010)
   c. U.S. Green Building Council LEED for Homes (April 2011) – Project Checklist

Appendix L: Section 08 16 13 Exterior Fiberglass Doors

Note: The application of this component specification assumes that the architect and building designer are familiar with the building science concepts relating to building system component interactions (e.g., moisture, condensation, and thermal profiles through building assemblies) and the implications associated with specifying particular materials for use. Not all components contained in these specifications are applicable for use in all building systems. It is the responsibility of the building designer and/or architect to select a component that is suitable for each particular building design. This specification is not intended to supersede local, state, or federal codes. This specification assumes that the installer possesses a good working knowledge of the applicable codes and regulations, safety practices, and methods necessary for proper installation.

1. PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Section 06 10 00: Rough Carpentry
B. Section 06 20 00: Finish Carpentry
C. Section 07 25 00: Weather Barriers Drainage Plane
D. Section 07 92 00: Joint Sealants
E. Section 08 71 00: Door Hardware

1.2 SECTION INCLUDES

A. Exterior fiberglass reinforced composite entry doors and associated frames and hardware.

1.3 SYSTEM DESCRIPTION

A. References:

1. AAMA 1304 – Voluntary Specification for Forced Entry Resistance of Side-Hinged Door Systems.
2. ASTM E 283 – Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
3. ASTM E 330 – Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Pressure Difference
4. ASTM E 331 – Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
5. ASTM E 547 – Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Cyclic Static Air Pressure Difference
6. ASTM E 1886 – Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
7. ASTM E 1996 – Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes
8. NFRC 100 – Procedure for Determining Fenestration Thermal Properties

9. NFRC 200 – Solar Heat Gain Coefficient and Visible Transmittance

1.4 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum three years experience.

B. Fire-Rated Doors: Provide doors that are listed and labeled by Warnock Hersey, fire-protection rating shown on Door Schedule and Drawings, based on testing according to NFPA 252.

1.5 SUBMITTALS

A. Submit under the provisions of Section 013300 – Submittal Procedures.

B. Submit the manufacturer's certificate under provisions of Section 014000 – Quality Requirements that products meet or exceed specified requirements.

C. Submit all requests for substitutions under provisions of Section 012500 – Substitution Procedures.

D. Product Data: The manufacturer's data sheet for each door on the door schedule.

1. Indicate frame configuration, anchor types and spacings, location of cutouts for hardware, reinforcement, and finish.
2. Indicate door elevations, internal reinforcement, closure method, and cutouts for glazing.
3. Manufacturer's Installation Instruction: Indicate special installation instruction.
4. Adjustable sill

E. Shop Drawings: Submit shop drawings indicating the location and size of each door, the elevation of each kind of door, details of construction, location and extent of hardware blocking, fire ratings, requirements for factory finishing, and other pertinent data.

1.6 WARRANTY

A. Warranty: The manufacturer's standard form, in which the manufacturer warrants doors to be free of manufacturing defects in materials or workmanship.

1. Warranty shall be in effect during the following period of time from the date of Substantial Completion:
   a. 25 years
2. Glass Vision Panels: 10-year limited warranty
3. Factory Stained Finish: 5-year warranty

2. PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Doors

1. Therma-Tru. http://thermatru.com
2. Jeld-Wen Windows & Doors. www.jeld-wen.com
3. Masonite. www.masonite.com

B. Frames

1. Ceco, Timely, and equal.

C. Substitutions: Submit in accordance with Section 012500 – Product Options & Substitutions.

2.2 MATERIALS

A. Doors: Provide doors of design as indicated on the Drawings.

1. Design: Two-Panel Stile and Rail.

2. Door Faces: 1/16-inch minimum thickness, fiberglass reinforced thermoset composite; surface lightly textured with 80 grit brushing, suitable to receive paint. Color per the Drawings.
3. Door Edges: Machinable kiln-dried pine, primed to match the color of faces; lock edge reinforced with laminated veneer lumber core; lockset area reinforced with solid blocking for hardware backup.
4. Thermal Performance: *[**Note to the Building Designer/Architect –** Although exterior doors constitute a small area of the exterior enclosure, their thermal performance must be at a high level so that energy efficiency and comfort objectives are not compromised.]* The thermal performance of doors must be independently tested and certified in accordance with National Fenestration Rating Council (NFRC) procedures for U-Factor (NFRC 100) and Solar Heat Gain Coefficient (NFRC 200). The following criteria must be met:
5. Solar Heat Gain Coefficient (SHGC): Meets ENERGY STAR SHGC Qualification Criteria for Residential Doors for the glazing level of the unit. www.energystar.gov
6. U-Factor: Meets ENERGY STAR U-Factor Qualification Criteria for Residential Doors for the glazing level of the unit. www.energystar.gov
7. Core: Foamed-in-place polyurethane, CFC free, density 2.0 pcf minimum. Meets thermal performance requirements.
8. Gasketing and Weatherstripping: Jacketed thermoset closed-cell foam, press fit in kerfs at jamb stops in frames. Extruded thermoplastic elastomer, finned and chambered design, press fit into bottom edge of doors. Corner pads at the bottom margin corners from jacketed thermoset closed-cell foam. Bottom gaskets integral with sills.
9. Hinges, Strikes: Steel with US26 satin chrome finish. Screws plated and finished to match hardware. Minimum hinge size 4 x 4 x 0.098 inches. Strikes shall be proprietary adjustable type, to permit in–out adjustment of door in frame, up to 3/16 inch.

2.3 WATER MANAGEMENT

A. General: Effectively integrate window with Section 072500 Weather Barriers Drainage Plane in order to shed water. Follow instructions shown on the Drawings. *[**Note to the Building Designer/Architect –** Exterior doors are a penetration through the building enclosure, and therefore they could be an entry point for bulk water. Detailed step-by-step drawings showing how each door flashing component at the sill, jambs, and head integrates with the building drainage plane will uphold the durability of the building.]* Use where noted and applicable the following materials in the integration process.
   1. Housewrap: As part of the building drainage plan, it is installed over exterior sheathing to reduce air infiltration and bulk water intrusion. It requires integration with the flashing system.
   2. Construction Tape: Use over joints and seams of housewraps and insulated sheathing that is modified as part of the window installation process, as well as at penetrations, to supplement the building envelope resistance to moisture and air intrusion.

3. Flashing: Install to provide a tear-resistant seal that resists bulk water intrusion around door openings.

B. Substitutions: Submit in accordance with Section 012500 – Product Options & Substitutions.

3. PART 3 EXECUTION

3.1 EXAMINATION

A. Verify substrate conditions under provisions of Section 013100 – Project Management and Coordination.
B. Verify that opening sizes and tolerances are acceptable.
C. Verify that surfaces and conditions are ready to receive work of this section. Notify the Owner's Representative of any existing conditions that will adversely affect execution. Beginning of execution will constitute acceptance of existing conditions.

3.2 INSTALLATION

A. Install doors and frames in strict accordance with the manufacturer's installation instructions.
B. Set doors and frames plumb, level, and true alignment, securely fastened to the floor and adjoining walls. Use concealed shims where necessary for alignment.
C. Install doors accurately maintaining specified clearances recommended by the manufacturer.
D. Hardware: Refer to Section 087100 for installation.

3.3 COMPLETION

A. Adjusting
   1. Adjust hardware and door movement for smooth operation and to provide weathertight closure.
   2. Rehang or replace doors that do not swing or operate freely.
   3. Replace doors that are damaged or do not comply with requirements. Repair or refinish doors if work complies with requirements and shows no evidence of repair or refinishing.
B. Cleaning
   1. Remove protective material from prefinished surfaces.
   2. Wash surfaces by the method recommended and acceptable to the door and sealant manufacturer; rinse and wipe surfaces clean prior to Substantial Completion.

3.4 COMMISSIONING/TESTING/VERIFICATION

A. General
   1. Comply with the verification, testing, and commissioning requirements of the national and/or regional certification programs outlined:
      a. U.S. Environmental Protection Agency Energy Star for Homes Version 3 – Thermal Enclosure System Rater Checklist
      b. U.S. Green Building Council LEED for Homes (January 2008) – Durability Inspection Checklist

Appendix M: Section 23 54 16.13 Gas-Fired Furnaces

Note: The application of this component specification assumes that the architect and building designer are familiar with the building science concepts relating to building system component interactions (e.g., moisture, condensation, and thermal profiles through building assemblies) and the implications associated with specifying particular materials for use. Not all components contained in these specifications are applicable for use in all building systems. It is the responsibility of the building designer and/or architect to select a component that is suitable for each particular building design. This specification is not intended to supersede local, state, or federal codes. This specification assumes that the installer possesses a good working knowledge of the applicable codes and regulations, safety practices, and methods necessary for proper installation. It also assumes that the installer understands the fundamentals of residential construction that affect the installation of insulation materials.

1. PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 – General Requirements, and the Drawings are collectively applicable to this Section.
B. Section 06 10 00: Rough Carpentry
C. Section 23 30 00: HVAC Air Distribution
D. Section 23 40 00: HVAC Air Cleaning Devices
E. Section 23 63 13: Air-Cooled Refrigerant Condensers

1.2 SECTION INCLUDES

A. Installation of gas-fired furnaces.
B. Installation of controls and controls wiring.

1.3 COMPONENT DESCRIPTION

A. Standards: Performance of the system is designed to meet or exceed the Reference Standards specified:
   1. American Society for Testing and Materials (ASTM)
   2. Air Conditioning Contractors of America (ACCA)
   3. Air Moving and Conditioning Association (AMCA)
   4. Air-Conditioning, Heating and Refrigeration Institute (AHRI)
   5. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
   6. American Society of Mechanical Engineers (ASME)
   7. American National Standards Institute (ANSI)
   8. CSA International
   9. Federal Specifications (Fed. Spec.)
   10. National Electrical Manufacturers Association (NEMA)
   11. National Fire Protection Association (NFPA)
   12. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
   13. Underwriters' Laboratories, Inc. (UL)

1.4 SUBMITTALS

A. Submit under the provisions of Section 013300 – Submittal Procedures.

B. Submit the manufacturer's certificate under provisions of Section 014000 – Quality Requirements that products meet or exceed specified requirements.
C. Submit all requests for substitutions under provisions of Section 012500 – Substitution Procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with the manufacturer's product data for handling and storage.
B. Delivery of materials to the site shall be coordinated with the designated construction schedule to minimize the amount of time the materials are stored on site prior to installation. Materials shall not be delivered more than two days prior to being installed.
C. Materials being stored on site shall be protected from exposure to the natural elements. Any material being stored outside of the building enclosure shall be placed on blocking to keep it elevated from sitting in direct contact with the ground and covered with a waterproof, breathable covering such as a canvas tarpaulin to prevent exposure to moisture.
D. Materials that have been damaged upon receipt at the site or exposed to moisture shall be brought to the attention of the site supervisor, removed from the site, and replaced with suitable materials.

1.6 QUALITY CONTROL

A. Provide certification that gas-fired furnace has been installed per the requirements of this section and the plan and code listing value. *[**Note to the Building Designer/Architect –** Installation technicians who are certified according to NATE (North American Technician Excellence) are preferred. These technicians have passed specialized HVAC tests.]* Certification shall be signed by the principal of the HVAC Subcontractor and the General Contractor.

1.7 WARRANTY

A. Provide the manufacturer's standard commercial warranty from the date of Substantial Completion.

1.8 INTENDED PERFORMANCE

A. The gas-fired furnace is intended to provide heated air to the HVAC Distribution system (Section 23 00 00). The gas furnace also provides the airflow for the Air-Cooled Refrigerant Condensing unit (Section 23 63 13). The furnace shall be installed so that no by-products of combustion are introduced into any space that is within the living space of the house.

2. PART 2 PRODUCTS

2.1 MANUFACTURERS:

A. Carrier Corporation. www.residential.carrier.com
B. Goodman. www.goodmanmfg.com
C. Lennox. www.lennox.com
D. Trane. www.trane.com
E. Substitutions: Submit in accordance with Section 012500 – Product Options & Substitutions.

2.2 PERFORMANCE REQUIREMENTS

A. Use only ENERGY STAR qualified gas-fired furnaces; Annual Fuel Utilization Efficiency (AFUE) is greater than or equal to 90%. www.energystar.gov *[**Note to the Building Designer/Architect –** The higher the AFUE value for the furnace, the*

more efficiently it will use gas to produce heat and the less homeowners will pay in utility bills. Furnace units with AFUE values up to 96% are readily available.]

B. All evaporators and condensing units and furnaces shall be properly matched as demonstrated by an attached AHRI certificate. *[**Note to the Building Designer/Architect –** Properly matching heating and cooling equipment components helps to ensure that they are operating at their optimum performance level and efficiency. The condensing unit in the outdoor unit must be matched with a suitable evaporator coil counterpart and fan in the furnace. This means that these two pieces of equipment are meant to operate together and can do so at the efficiencies noted in product specifications (providing other HVAC system components such as refrigerant lines have been installed to specification).]* If an AHRI certificate is not available, a copy of OEM-provided catalog data indicating acceptable combination selection and performance data shall be attached.

2.3 MATERIALS

A. General:

1. Refer to the schedule or Drawings for the specific equipment to be provided. Equipment associated with this system shall be furnished by one equipment manufacturer. Capacities shall be in accordance with the schedules shown on the Drawings. Capacities and efficiencies are to be considered minimum.
2. Dimensions: Equipment must conform to space requirements and limitations as indicated on the Drawings and as required for operation and maintenance. *[**Note to the Building Designer/Architect –** Gas furnaces should be located in conditioned space so that the efficiency of the HVAC air distribution system is optimized. Gas furnaces located in vented and unconditioned attics and crawlspaces are subject to temperature and humidity extremes that can be transferred to the air traveling through the unit, particularly if the unit is leaky.]* Equipment will not be accepted that does not readily conform to space conditions. Plenums shall be modified to suit the manufacturer's requirements. Refer to Section 233000 – HVAC Air Distribution for the sizing of the air distribution system.
3. Electrical: Electrical equipment shall be in accordance with NEMA Standards and UL listed where applicable standards have been established.

B. Gas-Fired Furnaces: Factory assembled and tested. CSA, AHRI, UL certified.

C. Controls: Controls and control wiring shall be properly matched with furnace and condensing unit to facilitate temperature, humidity (optional), and programmable control. Locate control units as shown on the Drawings. *[**Note to the Building Designer/Architect –** Controls that are properly matching with the heating and cooling equipment ensure that temperature and humidity (optional) conditions are maintained at set levels and arrived at through the efficient use of equipment. Controls offered by the manufacturer of the heating and cooling equipment are often the most suitable.]*

D. Other: As noted in the specifications and on the Drawings.

1. Air filtration and air purification devices and equipment
2. Dehumidification equipment
3. Humidification equipment

3. PART 3 EXECUTION

3.1 INSPECTION

A. Verify existing conditions under the provisions of Section 013100 – Project Management and Coordination.

B. The HVAC Contractor shall examine the site, compare it with the plans and specifications, and shall have satisfied himself as to the conditions under which the work is to be performed. No allowance shall subsequently be made in his behalf for any extra expense to which he may be put due to failure or neglect on his part to make such an examination.

C. Notify the Owner's Representative of any existing conditions that will adversely affect execution. Beginning of execution will constitute acceptance of existing conditions.

3.2 INSTALLATION

A. General

1. Comply with the manufacturer's product installation instructions and information.
2. Drawings accompanying these specifications, except where dimensions are shown, are diagrammatic and are not to be scaled. Drawings indicate generally the location of the equipment, duct, and piping, and while these are to be followed as closely as possible, all dimensions shall be checked at the site. Coordinate as necessary to conform to the building constructed and to fit the work of other trades.
3. All apparatus, ductwork, piping, and equipment shall fit into the available spaces in the building and must be introduced into the building at such time and in such manner as to cause no damage to the structure or finish. Refer to Section 233000 – HVAC Air Distribution for the sizing of the air distribution system.
4. All equipment connected to and part of the HVAC air distribution system shall be made as airtight as possible, using appropriate products as noted in the Drawings, to achieve duct leakage testing requirements noted in Section 3.3.A.1.a.
5. All equipment requiring services shall be accessible. It shall be the responsibility of the Contractor to ensure that no work done under other specification sections shall in any way block or otherwise hinder access panels or diminish the effectiveness of equipment vibration isolation.

B. Controls: All control wiring and devices required for the operation of the equipment shall be furnished and installed. Wiring, raceways, boxes, etc. for same shall be furnished and installed in accordance with applicable sections of the electrical specifications.

3.3 COMMISSIONING/TESTING/VERIFICATION

A. General

1. Comply with the verification, testing, and commissioning requirements of the national and/or regional certification programs outlined:
   a. U.S. Environmental Protection Agency Energy Star for Homes Version 3 – HVAC System Quality Installation Contractor Checklist; HVAC System Quality Installation Rater Checklist ***[Note to the Building Designer/Architect*** *– By following the HVAC related requirements noted in the ENERGY STAR for Homes Program and its associated checklists, the HVAC system will be airtight and energy efficient. Making the furnace more airtight may be necessary to achieve total HVAC system air leakage test requirements.]*
   b. ACCA Standard 5 HVAC Quality Installation Specifications (ANSI/ACCA 5 QI-2010)
   c. U.S. Green Building Council LEED for Homes (April 2011) – Project Checklist

Appendix N: Section 23 63 13 Air-Cooled Refrigerant Condensers

Note: The application of this component specification assumes that the architect and building designer are familiar with the building science concepts relating to building system component interactions (e.g., moisture, condensation, and thermal profiles through building assemblies) and the implications associated with specifying particular materials for use. Not all components contained in these specifications are applicable for use in all building systems. It is the responsibility of the building designer and/or architect to select a component that is suitable for each particular building design. This specification is not intended to supersede local, state, or federal codes. This specification assumes that the installer possesses a good working knowledge of the applicable codes and regulations, safety practices, and methods necessary for proper installation.

1. PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 – General Requirements, and the Drawings are collectively applicable to this Section.
B. Section 06 10 00: Rough Carpentry
C. Section 23 30 00 HVAC Air Distribution
D. Section 23 40 00: HVAC Air Cleaning Devices
E. Section 23 54 16.13: Gas-Fired Furnaces

1.2 SECTION INCLUDES

A. Installation of air-cooled refrigerant condensers

1.3 COMPONENT DESCRIPTION

A. Standards: Performance of the system is designed to meet or exceed the Reference Standards specified:
    1. American Society for Testing and Materials (ASTM)
    2. Air Conditioning Contractors of America (ACCA)
    3. Air Moving and Conditioning Association (AMCA)
    4. Air-Conditioning, Heating and Refrigeration Institute (AHRI)
    5. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
    6. American Society of Mechanical Engineers (ASME)
    7. American National Standards Institute (ANSI)
    8. CSA International
    9. Federal Specifications (Fed. Spec.)
    10. National Electrical Manufacturers Association (NEMA)
    11. National Fire Protection Association (NFPA)
    12. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
    13. Underwriters' Laboratories, Inc. (UL)

1.4 SUBMITTALS

A. Submit under the provisions of Section 013300 – Submittal Procedures.
B. Submit the manufacturer's certificate under provisions of Section 014000 – Quality Requirements that products meet or exceed specified requirements.
C. Submit all requests for substitutions under provisions of Section 012500 – Substitution Procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with the manufacturer's product data for handling and storage.
B. Delivery of materials to the site shall be coordinated with the designated construction schedule to minimize the amount of time the materials are stored on site prior to installation. Materials shall not be delivered more than two days prior to being installed.
C. Materials being stored on site shall be protected from exposure to the natural elements. Any material being stored outside of the building enclosure shall be placed on blocking to keep it elevated from sitting in direct contact with the ground and covered with a waterproof, breathable covering such as a canvas tarpaulin to prevent exposure to moisture.
D. Materials that have been damaged upon receipt at the site or exposed to moisture shall be brought to the attention of the site supervisor, removed from the site, and replaced with suitable materials.

1.6 QUALITY CONTROL

A. Provide certification that the air-cooled refrigerant condenser has been installed per the requirements of this section and the plan and code listing value. *[**Note to the Building Designer/Architect –** Installation technicians who are certified according to NATE (North American Technician Excellence) are preferred. These technicians have passed specialized HVAC tests.]* Certification shall be signed by the principal of the HVAC Subcontractor and the General Contractor.

1.7 WARRANTY

A. Provide the manufacturer's standard commercial warranty from the date of Substantial Completion.
B. 10-year compressor parts warranty from the date of Substantial Completion.

1.8 INTENDED PERFORMANCE

A. The air-cooled refrigerant condensing unit is intended to provide cooled and dehumidified air to the HVAC distribution system (Section 23 00 00) in conjunction with the fan in the Gas-Fired Furnace.

2. PART 2 PRODUCTS

2.1 MANUFACTURERS:

A. Carrier Corporation. www.residential.carrier.com
B. Goodman. www.goodmanmfg.com
C. Lennox. www.lennox.com
D. Trane. www.trane.com
E. Substitutions: Submit in accordance with Section 012500 – Product Options & Substitutions.

2.2 PERFORMANCE REQUIREMENTS

A. Use only ENERGY STAR qualified central air conditioners (for split systems); Seasonal Energy Efficiency Ratio (SEER) is greater than or equal to 14.5, and Energy Efficiency Ratio (EER) is greater than or equal to 12. www.energystar.gov *[**Note to the Building Designer/Architect –** The higher the SEER and EER values for the condensing unit, the more efficiently it will use electricity to produce cool air and the less homeowners will pay in utility bills. Condensing units with SEER values up to 20 are available.]*
B. All evaporators and condensing units and furnaces shall be properly matched as demonstrated by an attached AHRI certificate. *[**Note to the Building***

Designer/Architect – *Properly matching heating and cooling equipment components helps to ensure that they are operating at their optimum performance level and efficiency. The condensing unit in the outdoor unit must be matched with a suitable evaporator coil counterpart and fan in the furnace. This means that these two pieces of equipment are meant to operate together and can do so at the efficiencies noted in product specifications (providing other HVAC system components such as refrigerant lines have been installed to specification).]* If an AHRI certificate is not available, a copy of OEM-provided catalog data indicating acceptable combination selection and performance data shall be attached.

2.3 MATERIALS

A. General

1. Refer to the schedule or Drawings for the specific equipment to be provided. Capacities shall be in accordance with the schedules shown on the Drawings. Capacities and efficiencies are to be considered minimum.
2. Dimensions: Equipment must conform to space requirements and limitations as indicated on the drawings and as required for operation and maintenance. Equipment will not be accepted that does not readily conform to space conditions. Plenums shall be modified to suit the manufacturer's requirements.
3. Electrical: Electrical equipment shall be in accordance with NEMA standards and UL listed where applicable standards have been established.

B. Air-Cooled Refrigerant Condensers: Self-contained unit designated for outdoor installation. Factory assembled and tested. CSA certified. Units constructed in accordance with ANSI B9.1 and National Electrical Code. Unit performance shall be certified in accordance with ANSI/AHRI Standard 365.

1. Refrigerant in units shall be R-410A.

3. PART 3 EXECUTION

3.1 INSPECTION

A. Verify existing conditions under provisions of Section 013100 – Project Management and Coordination.

B. The HVAC Contractor shall examine the site, compare it with the plans and specifications and shall have satisfied himself as to the conditions under which the work is to be performed. No allowance shall subsequently be made in his behalf for any extra expense to which he may be put due to failure or neglect on his part to make such an examination.

C. Notify the Owner's Representative of any existing conditions that will adversely affect execution. Beginning of execution will constitute acceptance of existing conditions.

3.2 INSTALLATION

A. General

1. Comply with the manufacturer's product installation instructions and information. Connect services to the unit where called for, in complete accordance with the manufacturer's installation instructions.
2. Provide the Electrical Subcontractor with wiring diagrams and electrical data to permit power wiring connections to the unit.
3. Drawings accompanying these specifications, except where dimensions are shown, are diagrammatic and are not to be scaled. Drawings indicate generally the location of the equipment, duct, and piping, and while these are to be followed as closely as possible, all dimensions shall be checked at

the site. Coordinate as necessary to conform to the building constructed and to fit the work of other trades.

4. All apparatus, ductwork, and equipment shall fit into the available spaces in the building and must be introduced into the building at such time and in such manner as to cause no damage to the structure or finish. Refer to Section 233000 – HVAC Air Distribution for the sizing of the air distribution system.
5. All equipment requiring services shall be accessible. It shall be the responsibility of the Contractor to ensure that no work done under other specification sections shall in any way block or otherwise hinder access panels or diminish the effectiveness of equipment vibration isolation.
6. Charge the system with refrigerant after leak testing and in accordance with the manufacturer's installation instructions. *[**Note to the Building Designer/Architect** – An improperly charged (either undercharged or overcharged) system can experience the following problems: poor comfort because air will not be dehumidified properly; reduced efficiency because heat transfer in the refrigerant has been impaired; and reduced equipment reliability because the compressor is not being properly cooled or lubricated. These conditions can significantly shorten the life of a compressor and can increase homeowner operating costs and maintenance expenses.]*

3.3 COMMISSIONING/TESTING/VERIFICATION

A. General

1. Comply with the verification, testing, and commissioning requirements of the national and/or regional certification programs outlined:
   a. U.S. Environmental Protection Agency Energy Star for Homes Version 3 – HVAC System Quality Installation Contractor Checklist; HVAC System Quality Installation Rater Checklist *[**Note to the Building Designer/Architect –** By following the HVAC related requirements noted in the Energy Star for Homes Program and its associated checklists, the HVAC system will be an airtight and very efficient one that requires a minimum of energy to operate.]*
   b. ACCA Standard 5 HVAC Quality Installation Specifications (ANSI/ACCA 5 QI-2010)
   c. U.S. Green Building Council LEED for Homes (April 2011) – Project Checklist

Appendix O: Section 48 14 13.13 Solar Energy Collectors

Note: The application of this component specification assumes that the architect and building designer are familiar with the building science concepts relating to building system component interactions (e.g., moisture, condensation, and thermal profiles through building assemblies) and the implications associated with specifying particular materials for use. Not all components contained in these specifications are applicable for use in all building systems. It is the responsibility of the building designer and/or architect to select a component that is suitable for each particular building design. This specification is not intended to supersede local, state, or federal codes. This specification assumes that the installer possesses a good working knowledge of the applicable codes and regulations, safety practices, and methods necessary for proper installation. It also assumes that the installer understands the fundamentals of residential construction that affect the installation of complete grid-tied photovoltaic (PV) power systems, including all support structures necessary to mount the systems to the standard shingle roof. The system shall be rated at a minimum KW AC PTC as required per site.

1. PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 – General Requirements, and the Drawings are collectively applicable to this Section.

B. 07 30 00 Steep Slope Roofing

C. 26 00 00 Electrical

1.2 SECTION INCLUDES

A. PV array

1. Modules
2. Inverter
3. Power monitoring and data acquisition
4. All wiring and conduits
5. All module racking components and attachments to
6. Safety features to meet NEC Standards

1.3 COMPONENT DESCRIPTION

A. Standards: Performance of the component is designed to meet or exceed the Reference Standards and Resources specified:

1. American Society for Testing and Materials (ASTM)
2. National Electric Code (NEC)
3. American Society of Civil Engineers Standard for Minimum Design Loads for Buildings and Other Structures (ASCE 7)

B. PV Array

1. Unless otherwise specified or dictated by site condition, all PV arrays should be oriented to achieve maximum kWh production. *[**Note to the Building Designer/Architect** - The performance and efficiency of the PV system is greatly affected by the orientation of the system. Each system must be evaluated for proper orientation. PVWatts v.2 A Performance Calculator for Grid-Connected PV Systems is available for analysis of system*

configuration. http://rredc.nrel.gov/solar/calculators/PVWATTS/version2/. Researchers at the National Renewable Energy Laboratory developed PVWatts to permit non-experts to quickly obtain performance estimates for grid-connected PV systems. Version 2 can be run for locations within the 48 contiguous states, Alaska, and Hawaii.]

2. PV arrays should be located to prevent shading from trees, poles, or other structures between the hours of 9:00 a.m. and 3:00 p.m. *[**Note to the Building Designer/Architect** – Shading and soiling have an exponential effect on PV performance. Small amounts of shading can greatly reduce the energy production of the system.]*
3. PV arrays must be securely installed to the facility roof structure as dictated by site conditions to accommodate for wind loads.
4. PV array and supporting structure must comply with wind uplift requirements and wind loads per the American Society of Civil Engineers Standard for Minimum Design Loads for Buildings and Other Structures (ASCE 7).
5. PV array and auxiliary equipment must meet all seismic requirements.
6. Roof mounted arrays
   a. The weight of the PV array must not exceed roof structural limitations.
   b. Certification of the roof's structural compatibility for any equipment placed on the roof must be furnished from a licensed Structural Engineer.
   c. Systems should require minimal maintenance.

1.4 SYSTEM CONFIGURATION

A. Minimize the risk of vandalism, theft, and personal injury in the installation and operation of the systems.
B. Systems should require minimal maintenance.

1.5 SUBMITTALS

A. Shop Drawings displaying specific layout and location of the systems
B. Submit under the provisions of Section 013300 – Submittal Procedures.
C. Submit the manufacturer's certificate under provisions of Section 014000 – Quality Requirements that products meet or exceed specified requirements.
D. Submit all requests for substitutions under provisions of Section 012500 – Substitution Procedures.

1.6 REPLACEMENT AND SPARE PARTS

A. All system components must be clearly specified as to the type, manufacturer, and model number for later needs for replacement and service as required and must be documented in the System Manual.
B. A complete set of replacement fuses of the same type and rating for all fuses in the system must be provided.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with the manufacturer's product data for handling and storage.
B. Delivery of materials to the site shall be coordinated with the designated construction schedule to minimize the amount of time the materials are stored on site prior to installation. Materials shall not be delivered more than two days prior to being installed.

C. Materials being stored on site shall be protected from exposure to the natural elements. No material shall be stored outside of the building enclosure.
D. Materials that have been damaged upon receipt at the site or exposed to moisture shall be brought to the attention of the site supervisor, removed from the site, and replaced with suitable materials.

1.8 QUALITY CONTROL

A. Provide certification that the PV system has been installed per the requirements of this section and the plan and code listing value. Certification shall be signed by the principal of the insulation Subcontractor and the General Contractor.
B. PV system shall be installed by a North American Board of Certified Energy Practitioners (NABCEP) certified installer.

1.9 WARRANTY

*[**Note to the Building Designer/Architect** - Warranty life will need to be modified, depending on the product. Manufacturer warranties vary. Warranties will vary for different components of the PV system (i.e., modules and inverters will likely have differing warranty periods).]*

A. Provide the manufacturer's standard commercial warranty for a period of XX years from the date of installation.

1.10. INTENDED PERFORMANCE

A. Regardless of the level of energy efficiency a home can achieve through energy conservation measures, the home will still require the use of energy to operate many of the building's mechanical systems, lighting, and appliances. Residential scale solar PV systems are designed to use sunlight to generate electricity at the location where the electricity is needed. In certain municipalities, residences that have a grid-tied electrical system are permitted to sell their excess energy to the utility grid through a policy known as "net metering," whereby the owner of the PV system receives compensation from the utility for its net outflow of power. *[**Note to the Building Designer/Architect** - Grid-interactive PV systems are covered by specific provisions in the National Electric Code, which also mandates certain requirements for grid-interactive inverters.]* A grid-tied PV system is typically designed to generate electricity to partially or completely offset the electricity required from the utility; however, it is not intended to provide the electricity required by the home during all times of day or all times of year. The system will not generate electricity when sunlight is not present, and the home therefore will need to use electricity from the utility supplier.

2. PART 2 PRODUCTS

2.1 PV ARRAY

A. PV Modules
1. Manufacturers: Either monocrystalline or polycrystalline silicon flat-plate PV modules are acceptable, provided they are from one of the following manufacturers. Thin-film PV modules will not be considered.
a. Sharp. http://www.sharpusa.com/SolarElectricity.aspx
b. Kyocera. http://www.kyocerasolar.com/
c. Sanyo. http://us.sanyo.com/Solar

d. Solarworld. http://www.solarworld-usa.com/
e. Evergreen. http://evergreensolar.com

B. Micro-Inverters
1. Manufacturers:
a. Enphase. http://www.enphaseenergy.com/
b. SMA. http://www.sma-america.com
c. Satcon. http://www.satcon.es/pv_inverters/index.html

3. PART 3 EXECUTION

3.1 INSPECTION

A. Verify existing conditions under provisions of Section 013100 – Project Management and Coordination.
B. The installing contractor shall examine the site, compare it with the plans and specifications, and shall have satisfied himself as to the conditions under which the work is to be performed. No allowance shall subsequently be made in his behalf for any extra expense to which he may be put due to failure or neglect on his part to make such an examination.
C. Notify the Owner's Representative of any existing conditions that will adversely affect execution. Beginning of execution will constitute acceptance of existing conditions.

3.2 DESIGN

A. The base system design utilizes 210 kW, Sharp 235 modules. Any deviation from this module must have accompanying documentation substantiating the resultant AC-CEC system size is equal to or greater than the base system design. In addition, the system configuration must not exceed beyond the footprint of the existing design nor shall any portion of the system be shaded between the hours of 9:00 a.m. and 3:00 p.m. year round.
B. PV modules using cadmium must include an environmental impact statement, including any special maintenance requirements, and proper disposal/recycling of the modules at the end of their usual life. Modules containing cadmium must comply with the U.S. Environmental Protection Agency (EPA) Landfill Disposal Requirements. Any additional costs related to PV modules containing cadmium must clearly be identified.
C. Rated PV system capacity must be specified in direct current (DC) kilowatts (both STC and PTC ratings) and in alternating current (AC) kilowatts. Provide the AC loss assumptions with kWh output calculation.
1. The STC rating, or Standard Test Conditions rating, is also referred to as the kilowatt peak (kWp) DC output. Specific PV module manufacturer maximum and minimum power data must be specified for this rating.
2. The PTC rating, or PV USA Test Conditions rating, is the DC output based on 1,000 watts/square meter solar irradiance, 20°Celsius ambient temperature, and 1 meter/second wind speed. The PTC rating of CEC approved PC modules is available at the following website: http://www.consumerenergycenter.org/erprebate/index.html.
3. AC Loss Assumptions – Loss factors are used to convert theoretical DC output based on 1,000 watts/square meter solar irradiance, 20°Celsius ambient temperature, and 1 meter/second wind speed. The PTC rating of

CEC approved PV module is available at the following website: http://www.consumerenergycenter.org/erprebate/index.html.

D. The effective AC output must include losses for: DC cabling, connections, inverter module, coefficient of temperature, module mismatch, soiling, shading losses, transformer losses, and AC wiring.
   1. The mathematical method for specifying PV system output in kWh must be specified for each of the following steps:
      a. Calculate the annual kWh of the system using PVWatts Version2. http://rredc.nrel.gov/solar/calculators/PVWATTS/version2/
      b. Specify annual degradation expected over 20 years.
      c. Specify PV module efficiency and how it is calculated.
      d. Nationally Recognized Testing Laboratory listing and labeling.

3.3 INSTALLATION

A. General
   1. Comply with the manufacturer's product installation information for each type and for the conditions encountered.
   2. Installers require protective equipment as per the manufacturer's specifications.

3.4 COMMISSIONING/TESTING/VERIFICATION

A. General
   1. Comply with the verification, testing, and commissioning requirements of the national and/or regional certification programs outlined:
      a. National Electric Code (NEC)

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