4. “LOT 26 - MEADOWS AT CUMBERLAND RIDGE, DOWINGTOWN, PA

4.1 Executive Summary

G2 – Lot 26 (Madison Plan) – Meadows at Cumberland Ridge

Overview

The Madison Plan is the first prototype home constructed by Moser Builders in the Chester County area of Pennsylvania. The home represents a significant departure from their standard construction package, and brings in a new philosophy of low energy homes as a cornerstone for all of Moser’s projects moving forward. Moser Builders embraced multiple technology and construction practice changes that allowed for them to exceed the Building America performance targets of a minimum 50% source energy consumption reduction with no addition of renewable energy technologies. Most significant were the changes to the enclosure and framing practices by moving from a standard 2x4 wall with OSB sheathing, to an advanced framed 2x6 wall with 2” of insulating sheathing, and the inclusion of triple glazed windows. This coupled with high efficiency mechanical system design resulted in a very low energy use house.

Key Results

Not only did Moser builders adopt significant changes to their standard practice in order to meet the performance targets for the prototype home, they also helped explore new techniques that will be useful in filling some of the technology gaps that still exist with respect to cladding attachment over insulating foam sheathing. This project included some research into techniques for the installation of traditional three-coat stucco over ¾” furring strips. This work helps to expand the market readiness of advanced building practices.

Gate Status

Table 4.1: Stage Gate Status Summary

“Must Meet” Gate Criteria	Status	Summary
Source Energy Savings	Pass	The home was modeled at 51% source energy savings and meets the required minimum 50% source energy saving.
Prescriptive-Based Code Approval	Pass	The home was design and constructed following the prescriptive based code requirements for the area. The lateral bracing design was completed following the more stringent requirements of the 2009 IRC, however the design was checked for compliance with the both the requirements of the 2003 and 2006 IRC as well as. Gravity framing design was completed by a local structural engineering firm typically used by Moser Builders.
Quality Control Requirements	Pass	Moser builders, being a relatively small builder, have a core of people that provide quality assurance and quality control on all of their homes. Frequent site visits by the project manager coupled with task completion checklists are part of Moser Builders standard operating procedures.

“Should Meet” Gate Criteria	Status	Summary

Neutral Cost Target	Pass	The cost of the prototype house was compared to the standard builders practice. It was noted that the prototype house costs were slightly elevated due to extra time and effort required to learn and integrate the new construction techniques. It is predicted, that the actual cost during production will be several thousand dollars less.
Quality Control Integration	Pass	The new techniques were discussed and reviewed early in the project prior to beginning construction. BSC worked closely with the project manager to ensure clear understanding of the steps required for integration of the advanced building technologies.
Gaps Analysis	Pass	Moser builders use traditional three-coat stucco as one of their primary cladding systems for new homes. Installing stucco over furring strips is a technique that has been done in the past; however, it is no longer standard practice. Work is being done to try to develop techniques to install stucco over a foam sheathed wall with furring strips without adding significant cost to the project.

Conclusions

The incorporation of advanced framing for this home resulted in slightly higher framing costs for the home than what was typical for the builder. The framing cost (including labor) cost an additional $1700 over the standard framing package for the same plan. This overage was due to the learning curve required by the framer to adopt the advanced framing techniques. The framer predicted that time and cost savings (on the order of $1000 per house) will be realized on subsequent houses.

This home was constructed using insulating foam sheathing as the drainage plane for the wall assembly. The builder, while successful in the installation and incorporation of flashing and window systems, has decided to use a house wrap installed over top of the foam on subsequent houses. The time and labor associated with the installation of the sheathing tape was felt to be similar to the extra cost of the housewrap. Subsequent houses are intended to be covered with a housewrap prior to the installation of the furring strips.

The installation of the stone water table created some concerns for the builder and the assembly was modified to include OSB sheathing installed over the furring as a backing for the stucco cladding. While some mock-ups were constructed to see if there were means and methods available for little cost that would allow for a reliable installation of stucco over furring strips, a complete system has not been constructed at this point.

4.2 Introduction

4.2.1. Project Overview

Lot 26 of Meadows at Cumberland Ridge is the first prototype home constructed by Moser Builders in the Chester County area of Pennsylvania. The home represents a significant departure from their standard construction package, and brings in a new philosophy of low energy homes as a cornerstone for all of future Moser Builders projects.

Building Science Corporation (BSC) began working with Moser Builders after a presentation on the merits of high performance homes was given by Dr. Lstiburek (principal of BSC) to a NAHB Builder 20 Club of which Ted Moser (owner of Moser Builders) is a member. Of particular interest to Ted Moser were the benefits of advanced framing in terms of energy performance, reduced material use, and cost savings. This led to a significant change in the framing and enclosure design for prototype home from standard 2x4 walls at 16" on center with OSB sheathing to a full advanced famed package including 2x6 walls at 24" on center, single top and bottom plates, and engineered lateral braced design to eliminate most of the exterior wood sheathing, and the installation of 2" of insulating sheathing as the primary sheathing for the home. Coupled with this were increases in the insulation levels for the attic, a change to a fully insulated basement, use of triple glazed windows, and high efficiency mechanical equipment.

The home is single-family detached residences of approximately 3,800ft^2 with a conditioned basement. The project is located in DOE Climate Zone 4A. The Building America energy consumption reduction goal (minimum 50 % source energy consumption reduction compared to the Building America benchmark protocol) was met for this home. The home was modeled at a 51% savings. These efficiency goals were achieved entirely from energy consumption reduction strategies and not through the addition of renewable strategies to offset energy use.

Figure 4.2.1: House near completion

4.2.2. Project Information Summary Sheet

PROJECT SUMMARY	
Company	Moser Builders
Company Profile	Ted Moser is a third generation builder whose homes and communities throughout the Philadelphia area have won numerous regional and national awards. His son, TR, recently joined the firm, making Moser Builders a four generation success story.

Contact Information	Ted Moser Moser Builders 1171 Lancaster Avenue Suite 201 Berwyn, PA 19312 610.725.0812
Division Name	N/A
Company Type	Custom Home Builder
Community Name	Meadows at Cumberland Ridge
City, State	Downingtown, PA
Climate Region	4A

SPECIFICATIONS	
Number of Houses	1
Municipal Address(es)	15 Cumberland Drive Downingtown, PA 19335
House Style(s)	single family
Number of Stories	2
Number of Bedrooms	4
Plan Number(s)	Madison
Floor Area	3800
Basement Area	1775
Estimated Energy Reduction	51% over BA Benchmark
Estimated Energy Savings	$3,019
Estimated Cost	$335,000 – base construction cost
Construction Start	June 2009
Expected Buildout	November 2009

4.2.3. Targets and Goals

The goal for this project was Cold Climate 50% whole house energy savings over BA Benchmark. The project is located in climate zone 4A and is an example of a fully advanced framing design for a cold climate prototype home. The goal was to achieve the energy reduction primarily through the incorporation of advanced enclosure design and supplemented with high efficiency mechanical systems. No renewable energy sources were incorporated in the design in order to meet the energy reduction goals. The long term intent is to develop a new building package for Moser Builders to use as the cornerstone for all future developments.

Of particular interest on this project was the development of cladding attachment techniques for traditional three-coat stucco systems over 1x3 furring strips. While this technology is not new (it can be found on older buildings in the North East), it is no longer common and the skills used in the past are no longer commonly known by modern stucco installers. The goal was to try to develop means of installing stucco that would not deviate too far from standard stucco installation practices so that most stucco contractors could adopt the practice with relative ease, and that it would not add significant (or any) additional cost to the project.

4.3 Whole-House Performance and Systems Engineering

4.3.1. Energy Analysis Summary

Table 4.3.1: Estimated Whole House Energy Use for Lot 26 Meadows at Cumberland Ridge, Downingtown, PA

ESTIMATED WHOLE HOUSE ENERGY USE		
Source (MMBtu/year)	Site (MMBtu/year)	Area + Bsmt (sq ft)
226	140	3782 + 1776
	% Electric	No. of Bedrooms
	23%	4

With the enclosure and mechanical characteristics presented in Table 1.5 and Table 1.6, this plan achieves a performance level of 51% reduction relative to the Building America Benchmark.

4.3.1.1. Parametric Energy Simulations

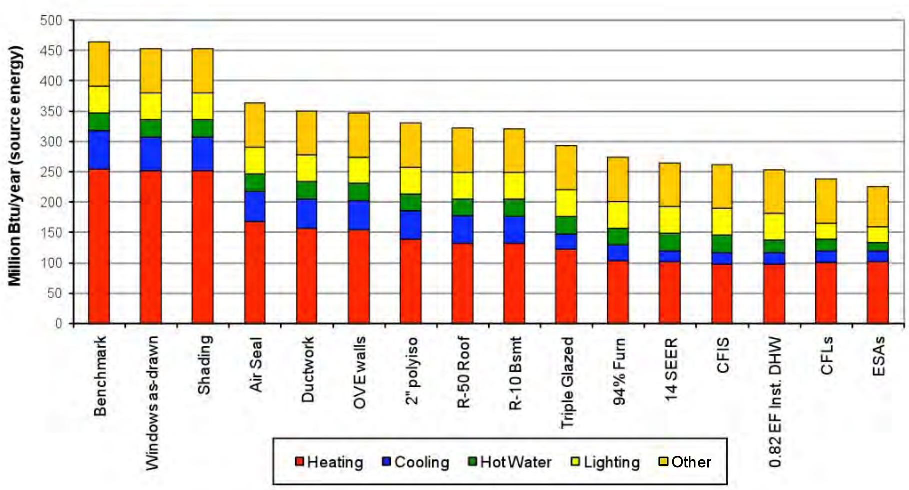


Figure 4.3.1: Parametric energy simulations for Lot 26 Meadows at Cumberland Ridge, Downingtown, PA

4.3.1.2. End-Use Site and Source Energy Summaries

Table 4.3.2: Summary of End-Use Site-Energy

	Annual Site Energy			
	BA Benchmark		Prototype 1	
End-Use	kWh	therms	kWh	therms
Space Heating	1559	2160	583	836
Space Cooling	5500	0	1456	0
DHW	0	268	0	122
Lighting*	3833		2268	
Appliances + Plug	5245	115	4749	115
OA Ventilation**	99		403	
Total Usage	16236	2543	9459	1073
Site Generation	0	0	0	0
Net Energy Use	16236	2543	9459	1073

*Lighting end-use includes both interior and exterior lighting

**This OA Ventilation energy consumption is for fan energy only, space conditioning is included in Space Heating and Cooling

Table 4.3.3: Summary of End-Use Source-Energy and Savings

			Source Energy Savings	
	Estimated Annual Source Energy		Percent of End-Use	Percent of Total
	BA Benchmark	Prototype 1	Prototype 1 savings	Prototype 1 savings
End-Use	106 BTU/yr	106 BTU/yr		
Space Heating	254	98	**61%**	**34%**
Space Cooling	63	17	**74%**	**10%**
DHW	29	13	**54%**	**3%**
Lighting*	44	26	**41%**	**4%**
Appliances + Plug	73	67	**8%**	**1%**
OA Ventilation**	1	5	**-306%**	**-1%**
Total Usage	464	226	**51%**	**51%**
Site Generation	0	0		**0%**
Net Energy Use	464	226	**51%**	**51%**

The "Percent of End-Use" columns show how effective the prototype building is at reducing energy use in each end-use category.

The "Percent of Total" columns show how the energy reduction in each end-use category contributes to the overall savings.

Lot 26 of Meadows at Cumberland Ridge achieves a 51% source energy consumption reduction when compared to the Building America Benchmark.

4.3.2. Discussion

4.3.2.1. Enclosure Design

Table 4.3.4 (below) summarizes the building enclosure assemblies used for this project.

Table 4.3.4: Enclosure Specifications

ENCLOSURE	SPECIFICATIONS
Ceiling	
Description -	trussed, vented attic
Insulation -	R-50 cellulose at ceiling level
Walls	
Description -	2x6 Advanced Framing
Insulation -	2" extruded polystyrene sheathing (R-10) with R-19 blown-in fiberglass
Foundation	
Description -	Poured concrete foundation
Insulation -	2" extruded polystyrene (R-10) under floor slab, R-11 roll batts on interior or walls
Windows	
Description -	Triple Glaze Low-E, IG, w/ Argon
Manufacturer -	Super Seal 1150 Series
U-value -	0.23
SHGC -	0.18
Infiltration	
Specification -	2.5 in^2 leakage area per 100 ft^2 envelope; 2538 CFM 50 goal
Performance test -	1588 CFM 50

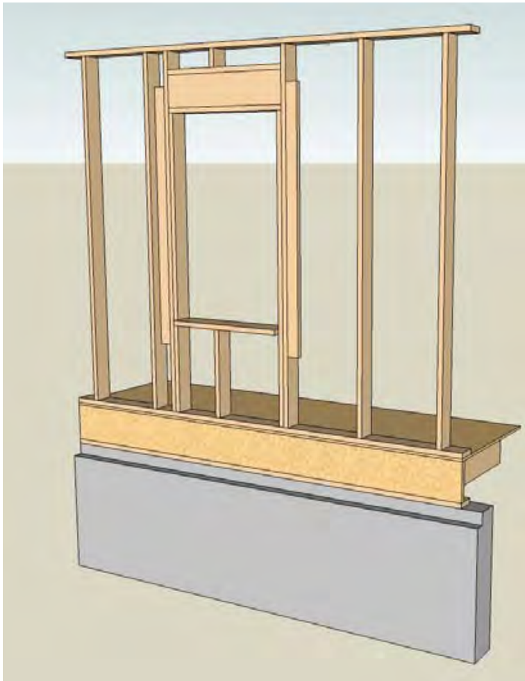


Figure 4.3.1: Advanced framing

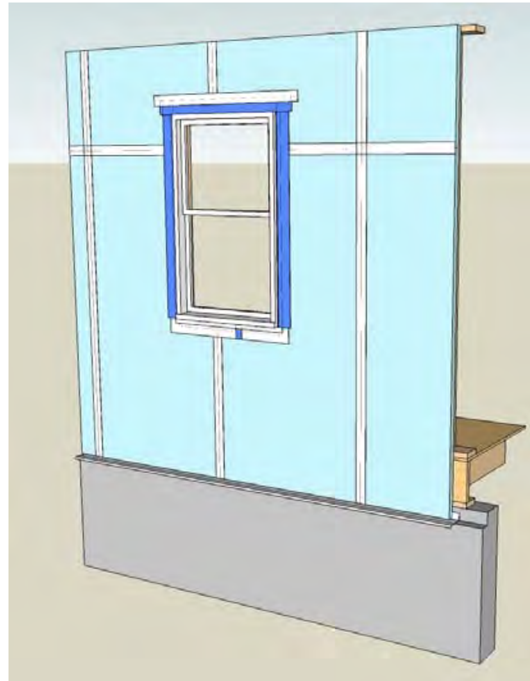


Figure 4.3.2: Insulating sheathing drainage plane

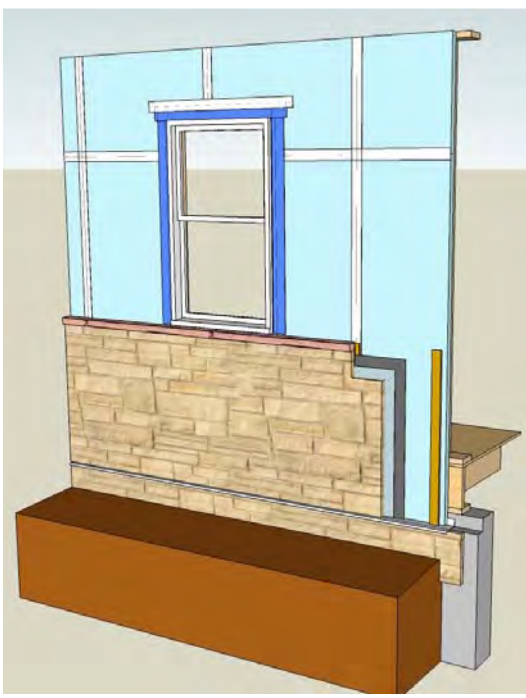


Figure 4.3.3: Cultured stone watertable over 1x3 furring strips

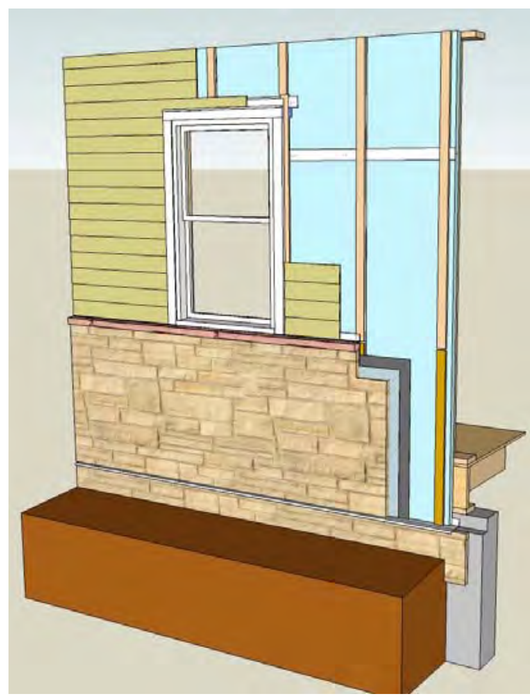


Figure 4.3.4: Fibercement siding over 1x3 furring strips

The design of the building enclosure focused on low conductance assemblies. The roof was designed as a vented attic with trussed framing and the insulation at the ceiling plane. For this home, the insulation level was set at R-50.

To encourage efficient material use and decrease costs, the walls were designed incorporating advanced framing techniques including 2x6 studs at 24" on center, single top and bottom plates, two-stud corners, single headers, and lateral braced panels where required. The exterior of the wall were sheathed with 2" of extruded polystyrene (1.5" were used over lateral braced panels). The extruded polystyrene was also designed as the drainage plane for the wall assembly requiring all of the joints to be taped and sealed and all elements flashed back to the face of the foam. The overall effective thermal resistance of the wall was determined to be R-24 (based on the isothermal planes method as described in ASHRAE Fundamentals Chapter 23). This is a significant improvement over the builders' standard practice of 2x4 studs framed at 16" on center which has an effective R-Value of R-10.

The foundation also represented a significant departure for Moser Builders. Typical practice for the area is to provide unconditioned basements with the insulation installed in the first floor framing. The prototype house was design as a conditioned basement with R-13 rigid insulation installed on the walls and R-10 extruded polystyrene below the slab. As a cost saving measure, the interior rigid insulation was substituted for an R-11 fiberglass roll batt system. The recommendations were to use a perforated system to allow for some drying to the interior basement space.

Windows are typically a weak link in the enclosure, often accounting for a significant amount of the conductance energy loss as well as being a source for air infiltration. Triple glazed low-E windows were included as part of the low conductance enclosure design. The windows are a Superseal 1150 Series window with Solarban XL70 Low-E coatings and Argon gas fill providing a manufacturers NFRC rating of U = 0.23, and SHGC = 0.18.

The air tightness for this project is based on the airtight drywall approach combined with a critical seal approach. The perimeter of the drywall and all penetrations are to be caulked and sealed. In addition, areas such as rim boards (where the drywall is no longer continuous), and electrical and plumbing penetrations through the ceiling plane are targeted for sealing with urethane foam.

4.3.2.2. Mechanical System Design

Table 4.3.5 (below) summarizes the mechanical systems used by this project.

Table 4.3.5: Mechanical system specifications

MECHANICAL SYSTEMS	SPECIFICATIONS
Heating	
Description -	94% AFUE sealed combustion natural gas furnace
Manufacturer & Model -	Carrier #58MVB Series
Cooling (outdoor unit)	
Description -	14 SEER Air Conditioner
Manufacturer & Model -	Carrier #24ACB Series with a TXV Coil and Puron refrigerant
Cooling (indoor unit)	
Description -	14 SEER air conditioner
Manufacturer & Model -	Carrier CNPVP3621ATAABAA
Domestic Hot Water	
Description -	0.82 EF instantaneous natural gas

MECHANICAL SYSTEMS	SPECIFICATIONS
Manufacturer & Model -	Rinnai 75LSi
Distribution	
Description -	R-6 flex duct runouts in conditioned space
Leakage -	none to outside (5% or less)
Ventilation	
Description -	Supply-only system integrated with AHU,43 CFM 33% Duty Cycle: 10 minutes on; 20 minutes off
Manufacturer & Model -	Aprilaire 8126 Ventilation Control System
Return Pathways	
Description -	Transfer grilles/jump ducts at bedrooms, central return
Dehumidification	
Description -	none
Manufacturer & Model -	N/A
PV System	
Description -	none
Manufacturer & Model -	N/A
Solar Hot Water	
Description -	none
Manufacturer & Model -	N/A

The mechanical design uses all high efficiency sealed combustion appliances. The furnace is a 94% condensing furnace with a variable speed air handler. This is coupled with a 14 SEER air conditioning system to provide the space conditioning for the house. The system is a single system with two zone dampers to control the first and second floor separately.

All of the duct work is contained within the conditioned space. The supplies are carried in a central core wall (double 2x4 interior wall) and connected to high wall supply registers. The return pathways are through jump ducts and transfer grilles connecting the perimeter spaces to multiple central returns.

The ventilation strategy is a supply only system integrated with the central air handler. The system is controlled with an Aprilaire 8126 Ventilation Control System and initially set to run on a 33% duty cycle (10mins on 20mins off). This has been found to provide comfort and pollutant control due to both ventilation (dilution) and mixing of the interior air.

The domestic hot water system used in the design is a sealed combustion instantaneous gas hot water system with an 0.82 EF.

4.3.2.3. Lighting and Miscellaneous Electrical Loads

The lighting design for the home incorporated a minimum of 80% compact fluorescent lamps to be included in the home.

Appliances provided by the builder are Energy Star rated where applicable.

4.3.2.4. Site-generated Renewable Energy

No site generated renewable technologies were included in the design of the project. The location of the house, orientation, and surrounding site conditions would allow for the later addition of a PV array or solar hot water system if desired.

4.4 Construction Support

4.4.1. Construction Overview

Several site visits were conducted to help with the integration of the advanced building techniques and technologies associated with the prototype home.

The first site visit was conducted on Wednesday June 10, 2009, and was coordinated so that a representative from BSC was present on the first day of framing to help guide the framer on how to execute the advanced framing details. Present during this site review was the local building code official, another builder known by Moser Builders through the NAHB Builder 20 Club, and two engineers from the structural consultant. Framing details as well as sheathing attachment, cladding attachment, window installation and integration, flashing, and air sealing locations were discussed and reviewed.

Figure 4.4.1: Advanced framing (lateral brace panel in corner, single header, single top and bottom plates)

The second site visit was conducted on August 13, 2009 and was focused on the rough in of the mechanical system as well as the installation of the water management system. The water management system for the house utilized the exterior foam sheathing as the primary drainage plane element. In order to use the foam as a drainage plane, all of the joints were required to be taped and sealed. In the field of the wall, the installation of the sheathing tape was accomplished with no real difficulties. At the corners, the sheathing tape was swapped for a self-adhered membrane flashing. The wider flashing was able to more easily cover the joint and the increased are provided for better overall adhesion to the foam sheathing. All mechanical penetrations were integrated using a pre-manufactured flashing system.

Figure 4.4.2: Kick out flashing at roof to wall and self-adhered membrane at building corners

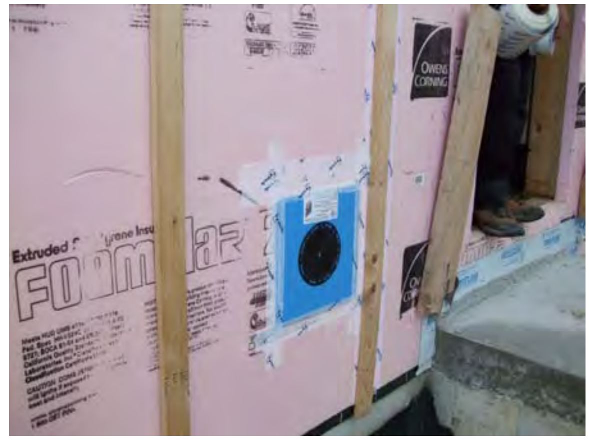


Figure 4.4.3: Pre-manufactured mechanical penetration flashing

The window frame profile did not provide enough protrusion past the face of the foam sheathing to allow the fiber-cement siding to terminate properly against the frame. A few different options were discussed, however ultimately the decision was made by the builder to create custom site bent metal flashing returns (similar to vinyl siding J-channels) in order to accept the edge of the siding.

Figure 4.4.4: Custom metal channel at window perimeter

The attachment of the stucco water table caused some concern for the builder. While mock-ups of several stucco cladding installation were prepared in order to try various techniques to install the stucco systems directly over 1x3 furring strips (the intention was to develop an approach for low additional cost to the builder), the builder still did not feel entirely comfortable in integrating the propose systems into the construction of the home. Alternately, a layer of ½” OSB was installed over the furring strips to provide a backing for the stucco.

4.4.2. Educational Events and Training

No educational events were held.

4.4.3. Systems Testing

System testing was completed November 4th, 2009. The home was tested for enclosure air leakage as well duct leakage to outside. For the air infiltration testing the BA target was 2.5 in^2 of leakage per 100 ft^2 of enclosure area. This ratio provided a CFM 50 target of 2538. The home tested well this maximum with a CFM 50 value of 1588.

The connectivity of the duct system with respect to the exterior was so minimal that it was below the measurement capabilities of the monometer being used. This gave a zero leakage to exterior result for the performance testing.

4.4.4. Monitoring

The Madison plan is a common house plan used by Moser Builders in their subdivisions. Utility bills are intended to be collected from this home as well as other homes based on the Madison plan to compare any differences in performance.

4.5 Project Evaluation

The following sections evaluate the research project results based on the ability to integrate advanced systems with production building practices in prototype homes. References are made to the results from field tests and energy simulations, which are included as an appendix to this report.

4.5.1. Source Energy Savings

Requirement:	*Final production home designs must provide targeted whole house source energy efficiency savings based on BA performance analysis procedures and prior stage energy performance measurements.*
Conclusion:	***Pass***

The home met the minimum source energy consumption reduction of 50% over the Building America Benchmark. The home was modeled at an energy savings of 51%. This reduction was achieved without the addition of renewable energy technologies. While renewable technologies were not part of the initial design and construction, the house plan and orientation would allow for the easy integration of PV's.

The focus was on a high efficiency enclosure. Some of the main strategies were through the incorporation of advanced framing and insulating sheathing as well as the use of triple glazed windows.

The mechanical design used all high efficiency equipment including a 94% sealed combustion furnace, 14 SEER air conditioner, and a 0.82 EF instantaneous gas hot water system.

4.5.2. Prescriptive-based Code Approval

Requirement:	*Must meet prescriptive or performance safety, health and building code requirements for*

	new homes.
Conclusion:	***Pass***

The local building code for the area is based on the 2003 IRC. The home was constructed under the prescriptive requirements of the local building code. For certain aspects (including lateral bracing and framing), the design was checked against the current local code as well as newer codes (2006 IRC and 2009 IRC) for compliance. Where required to push the design further than what was explicitly permitted by the building code, a local structural engineer provided analysis to ensure that proper life safety standards were maintained.

4.5.3. Quality Control Requirements

Requirement:	*Must define critical design details, construction practices, training, quality assurance, and quality control practices required to successfully implement new systems with production builders and contractors.*
Conclusion:	***Pass***

Given the significant departure in the framing techniques from what was standard practice for the builder, some close work between BSC and the builder at the preliminary stages of the project was done. Prior to the beginning of framing, BSC held a meeting with the builder to discuss the required details and the departures from typical framing practices that would be encountered, and details for water management design for the use of foam sheathing as the drainage plane.

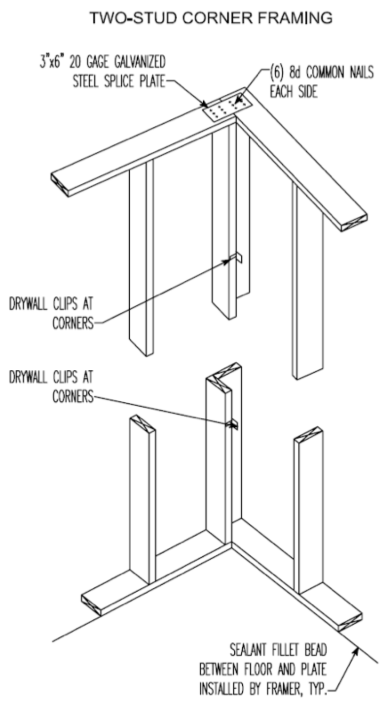


Figure 4.5.1: Example framing detail provided to Moser Builders

Figure 4.5.2: Use of framing detail

In conjunction with this meeting, BSC was also on site during the first day of framing to work with the project manager, framer, local code official, and structural engineer regarding advanced framing construction. This meeting helped to integrate all of the different parties involved and provided an open forum for all to voice concerns and ask questions.

For other aspects of the design of the home, there were only minimal deviations from the builders' standard practice and significant training was not required. To maintain a quality product, Moser Builders has as part of their standard operating procedures, a checklist system used by the project manager to ensure all aspects of the construction are completed and reviewed.

4.5.4. Neutral Cost Target

Requirement:	*The incremental annual cost of energy improvements, when financed as part of a 30 year mortgage, should be less than or equal to the annual reduction in utility bill costs relative to the BA Benchmark.*
Conclusion:	***Pass***

The significant energy reductions led to significant utility bill savings. The numbers used in the analysis were based on actual costs provided by the builder. The change from the builders' previous standard practice (very close to code minimum) to the prototype home were easily compared given that the same floor plan has been built previously by the builder and the actual construction costs were known.

Neutral Cost Analysis Worksheet

Updated January 16, 2009

bhendron:
New tab added for neutral cost calculations

	Annual Electric Energy (Site)			Annual Gas Energy (Site)			
	Benchmark	Builder Standard Practice (Optional)	Prototype House	Benchmark	Builder Standard Practice (Optional)	Prototype House	Annual Utility Bill Reduction vs Benchmark
End Use	(kWh/yr)	(kWh/yr)	(kWh/yr)	(therms/yr)	(therms/yr)	(therms/yr)	($/yr)
Space Heating	1559		583	2160		836	$2,103
Space Cooling	5500		1456				$485
DHW	0		0	268		122	$219
Lighting	3833		2268				$188
Appliances and MELs	5245		4749	115		115	$60
Ventilation	99		403				($36)
Total Usage	**16236**	**0**	**9459**	**2543**	**0**	**1073**	**$3,019**
Site Generation							$0
Net Energy Use	**16236**	**0**	**9459**	**2543**	**0**	**1073**	**$3,019**
Added Annual Mortgage Cost w/o Site Gen.							**$2,599**
Net Cash Flow to Consumer w/o Site Gen.							**$419**
Added Annual Mortgage Cost with Site Gen.							**$2,599**
Net Cash Flow to Consumer with Site Gen.							**$419**

Local Marginal Electricity Price	Local Marginal Gas Price
($/kWh)	($/therm)
$0.12	$1.50

Neutral Cost Criteria Met?	Yes

Figure 4.5.3: Neutral Cost Analysis Summary - Lot 26 Meadows at Cumberland Ridge

Measure	Builder Standard Practice (Optional)	Code Minimum House*	Prototype House*	Total Incremental Cost + 10% markup)	Amortized Annual Cost (30 year mortgage, 7% interest)	Footnotes
Thermal Enclosure:	$0	$0	$23,100	$25,410	$2,029	
Roof / Attic	$0	$0	$2,000	$2,200	$176	
Cathedral Roof	$0	$0	$0	$0	$0	
Flat Ceiling	$0	$0	$2,000	$2,200	$176	
Radiant Barrier	$0	$0	$0	$0	$0	
Other Roof Attic Measure	$0	$0	$0	$0	$0	
Wall	$0	$0	$10,200	$11,220	$896	
Cavity Insulation	$0	$0	$2,000	$2,200	$176	
Insulating Sheathing	$0	$0	$6,500	$7,150	$571	
Advanced Framing	$0	$0	$1,700	$1,870	$149	
Other Wall Measure	$0	$0	$0	$0	$0	
Foundation	$0	$0	$10,600	$11,660	$931	
Slab	$0	$0	$1,600	$1,760	$141	
Crawlspace	$0	$0	$0	$0	$0	
Basement	$0	$0	$9,000	$9,900	$790	
Air Infiltration Reduction	$0	$0	$300	$330	$26	
Other Enclosure Measures	$0	$0	$0	$0	$0	
Windows:	$0	$0	$4,000	$4,400	$351	
Glazing: *U-Factor / SHGC*	$0	$0	$4,000	$4,400	$351	
Slider (horz)	$0	$0	$0	$0	$0	
Slider (vert)	$0	$0	$0	$0	$0	
Fixed	$0	$0	$0	$0	$0	
Patio	$0	$0	$0	$0	$0	
French	$0	$0	$0	$0	$0	
Other Window Measures	$0	$0	$0	$0	$0	
HVAC System:	$0	$0	$850	$935	$75	
Furnace: AFUE	$0	$0	$500	$550	$44	
A/C: SEER	$0	$0	$350	$385	$31	
Ducts	$0	$0		$0	$0	
Ventilation	$0	$0	$0	$0	$0	
Other HVAC Measures	$0	$0	$0	$0	$0	
Water Heating:	$0	$0	$750	$825	$66	
Water Heater Size	$0	$0	$0	$0	$0	
Solar System	$0	$0	$0	$0	$0	
Tankless	$0	$0	$750	$825	$66	
Distribution Type	$0	$0	$0	$0	$0	
Other Water Heating	$0	$0	$0	$0	$0	
Lighting:	$0	$0	$150	$165	$13	
Hard Wired Fluorescents	$0	$0	$0	$0	$0	
Compact Fluorescents	$0	$0	$150	$165	$13	
Other Lighting Measures	$0	$0	$0	$0	$0	
Appliances:	$0	$0	$750	$825	$66	
Energy Star	$0	$0	$750	$825	$66	
Other Appliance Measures	$0	$0	$0	$0	$0	
Misc Electric Loads:	$0	$0	$0	$0	$0	
Home Automation	$0	$0	$0	$0	$0	
Other MEL Measures	$0	$0	$0	$0	$0	
Other Measures	$0	$0	$0	$0	$0	
3rd Party Inspections and QA Testing	$0	$0	$0	$0	$0	
Total Energy Efficiency Investment	$0	$0	$29,600	$32,560	$2,599	
Site Generation	$0	$0	$0	$0	$0	
Total with Site Generation	$0	$0	$29,600	$32,560	$2,599	
REBATES / INCENTIVES	$0	$0	$0	$0	$0	
SMUD Rule 15 Hook Up Fee Discount	$0	$0	$0	$0	$0	
Incentive for Lighting and Energy Star	$0	$0	$0	$0	$0	
SMUD PV Buydown	$0	$0	$0	$0	$0	
Other	$0	$0	$0	$0	$0	
Total Incremental Cost to Buyer Including Incentives	$0	$0	$29,600	$32,560	$2,599	

Figure 4.5.4: Neutral Cost Analysis Worksheet - Lot 26 Meadows at Cumberland Ridge

Even though there were some additional costs associated with this project due to the learning curves needed for the framer and contractor adopting the advanced framing and the integration of insulating sheathing as the primary sheathing and drainage plane, the home still met the target for neutral cost.

4.5.5. Quality Control Integration

Requirement:	*Health, Safety, Durability, Comfort, and Energy related QA, QC, training, and commissioning requirements should be integrated within construction documents, contracts and BA team scopes of work.*
Conclusion:	***Pass***

The quality control for the advanced building systems was integrated into the existing quality control strategy incorporated by Moser Builders. As part of their standard operations procedures, site reviews performed by the projected manager reviews the different stages of construction and checks for proper installation and completion prior to proceeding to the next phase. For this project, the integration was done by educating the project manager on the critical areas of the framing, installation of insulating sheathing, and integration of windows and other flashing systems. Information documents and construction details were provided to Moser Builders regarding the critical areas of the design and construction. Support was provided by site reviews conducted by BSC as well as phone and email exchanges.

4.5.6. Gaps Analysis

Requirement:	*Should include prototype house gaps analysis, lessons learned, and evaluation of major technical and market barriers to achieving the targeted performance level.*
Conclusion:	***Pass***

The installation of exterior insulating sheathing has specific requirements for cladding attachment. For thin amounts of insulating sheathing (1.5" or less), it is usually possible, given currently available fasteners lengths, to attach the cladding trough the foam directly back to the structure. For greater thicknesses of insulating sheathing (2" or more), the cladding is typically attached via furring strips (or other support system) that are fastened back to the structure. These furring strips are useful from both a cladding attachment as well as a water management perspective. Attaching siding materials (wood, vinyl, fiber-cement) is straightforward and does not pose any concerns; however the application of a traditional three coat stucco cladding does create a challenge.

It is possible to simply install a layer of sheathing over the furring strips in order to provide a nail base and structural back up for the stucco cladding. This increases the cost of the system which may make the use of stucco over the foam less desirable to builders.

The challenge is to develop techniques that will allow for the reliable installation of stucco cladding over furring strips at little to no additional cost for the builder. Historically, this approach has been used successfully as some turn of the century buildings in the North East are clad with stucco over furring strips with no sheathing for support. This practice is no longer commonly used and the techniques are not known to modern day stucco contractors.

Some work was completed to build mock ups of potential stucco installation methods; however the builder was concerned about long term performance of the system and opted to use a layer of OSB sheathing for the installation of the stone water table on the front on the home. Working on developing stucco cladding attachment is still required to complete the suit of cladding systems.

This home was constructed using insulating foam sheathing as the drainage plane for the wall assembly. The builder, while successful in the installation and incorporation of flashing and window systems, has decided to use a house wrap installed over top of the foam on subsequent houses. The time and labor associated with the installation of the sheathing tape was felt to be similar to the extra cost of the housewrap. Subsequent houses are intended to be covered with a housewrap prior to the installation of the furring strips.

4.6 Conclusions/Remarks

The Madison Plan is the first prototype home constructed by Moser Builders in the Chester County area of Pennsylvania. The home represents a significant departure from their standard construction package, and brings in a new philosophy of low energy homes as a cornerstone for all of Moser's projects moving forward. Most significant were the changes to the enclosure and framing practices by moving from a standard 2x4 wall with OSB sheathing, to an advanced framed 2x6 wall with 2" of insulating sheathing, and the inclusion of triple glazed windows. This coupled with high efficiency mechanical system design resulted in a very low energy use house.

The home is single-family detached residences of approximately 3,800ft^2 with a conditioned basement. The project is located in DOE Climate Zone 4A. The Building America energy consumption reduction goal (minimum 50 % source energy consumption reduction compared to the Building America benchmark protocol) was met for this home. The home was modeled at a 51% savings. These efficiency goals were achieved entirely from energy consumption reduction strategies and not through the addition of renewable strategies to offset energy use.

Most of the advanced construction technologies and practices were effectively adopted. The integration of the technologies was done through some close work between BSC and the builder at the preliminary stages of the project as well as ongoing review and quality control provided by Moser Builders' project manager. The main hurdle of the project was related to the attachment of the stucco water table. While mock-ups of several stucco cladding installation were prepared in order to try various techniques to install the stucco systems directly over 1x3 furring strips (the intention was to develop an approach for low additional cost to the builder), the builder still did not feel entirely comfortable in integrating the propose systems into the construction of the home. Alternately, a layer of ½" OSB was installed over the furring strips to provide a backing for the stucco.

Overall the project was very successful. The framing systems and insulation strategies are currently being incorporated in a new prototype home that is intending to take some of the lessons learned from this project (such as incorporating housewrap over the foam sheathing in lieu of taping and sealing the joints in the insulating sheathing). Ultimately, this prototype will provide the base design for a 25 lot community in the Chester County region of Pennsylvania.

4.7 Appendices

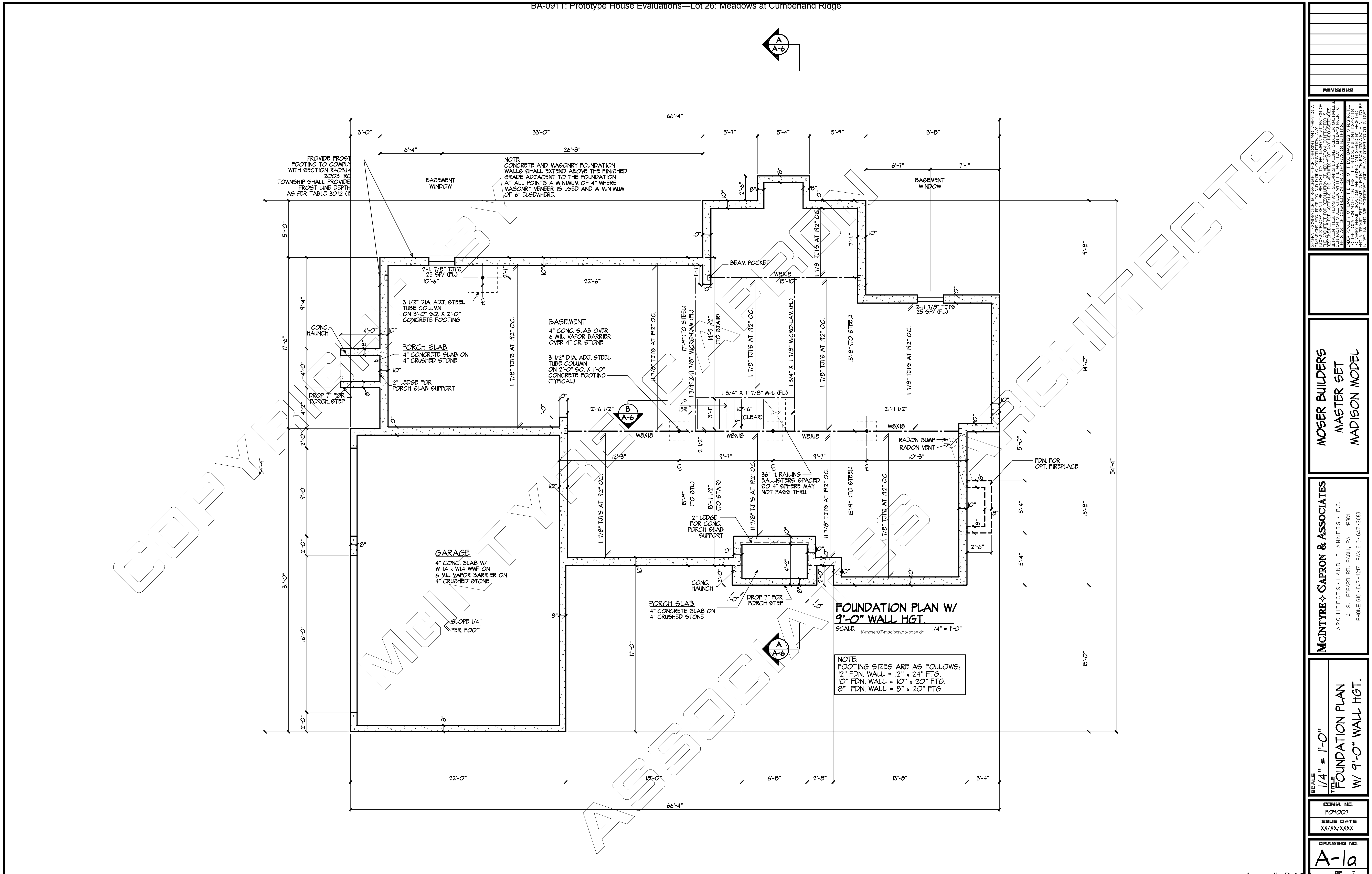
4.7.1. Madison Plans

4.7.2. Lateral Bracing Design

4.7.3. Energy Analysis

4.7.4. Madison Manual J Analysis

Appendix D.4.7.1
Madison Plans


FOUNDATION PLAN W/ 9'-0" WALL HGT.
SCALE: 1/4" = 1'-0"
NOTE:
CONCRETE AND MASONRY FOUNDATION WALLS SHALL EXTEND ABOVE THE FINISHED GRADE ADJACENT TO THE FOUNDATION AT ALL POINTS A MINIMUM OF 4" WHERE MASONRY VENEER IS USED AND A MINIMUM OF 6" ELSEWHERE.
PROVIDE FROST FOOTING TO COMPLY WITH SECTION R403.1.4 2003 IRC TOWNSHIP SHALL PROVIDE FROST LINE DEPTH AS PER TABLE 301.2 (1)
BASEMENT WINDOW
BASEMENT
4" CONC. SLAB OVER 6 MIL. VAPOR BARRIER OVER 4" CR. STONE
3 1/2" DIA. ADJ. STEEL TUBE COLUMN ON 2'-0" SQ. X 1'-0" CONCRETE FOOTING (TYPICAL)
3 1/2" DIA. ADJ. STEEL TUBE COLUMN ON 3'-0" SQ. X 2'-0" CONCRETE FOOTING
PORCH SLAB
4" CONCRETE SLAB ON 4" CRUSHED STONE
2" LEDGE FOR PORCH SLAB SUPPORT
CONC. HAUNCH
DROP 7" FOR PORCH STEP
BEAM POCKET
W8X18
11 7/8" TJI'S AT 19.2" OC.
RADON SUMP
RADON VENT
FDN. FOR OPT. FIREPLACE
36" H. RAILING BALLISTERS SPACED SO 4" SPHERE MAY NOT PASS THRU.
GARAGE
4" CONC. SLAB W/ W 1.4 x W1.4 WWF ON 6 MIL VAPOR BARRIER ON 4" CRUSHED STONE
SLOPE 1/4" PER FOOT
NOTE:
FOOTING SIZES ARE AS FOLLOWS:
12" FDN. WALL = 12" x 24" FTG.
10" FDN. WALL = 10" x 20" FTG.
8" FDN. WALL = 8" x 20" FTG.
66'-4"
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SCALE 1/4" = 1'-0"
TITLE FOUNDATION PLAN W/ 9'-0" WALL HGT.
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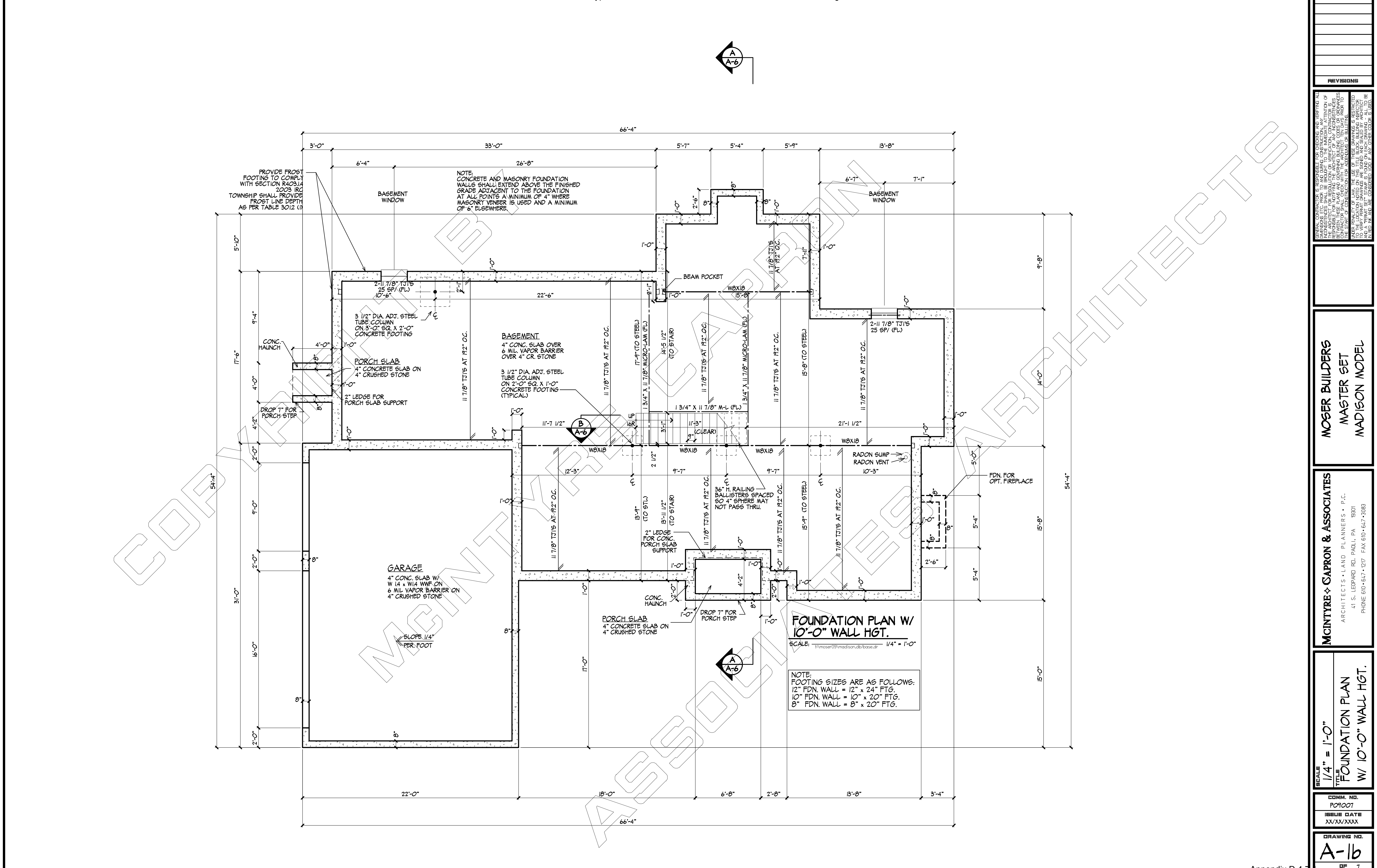
FOUNDATION PLAN W/ 10'-0" WALL HGT.
SCALE: 1/4" = 1'-0"
NOTE:
CONCRETE AND MASONRY FOUNDATION WALLS SHALL EXTEND ABOVE THE FINISHED GRADE ADJACENT TO THE FOUNDATION AT ALL POINTS A MINIMUM OF 4" WHERE MASONRY VENEER IS USED AND A MINIMUM OF 6" ELSEWHERE.
PROVIDE FROST FOOTING TO COMPLY WITH SECTION R403.1.4 2003 IRC TOWNSHIP SHALL PROVIDE FROST LINE DEPTH AS PER TABLE 301.2 (1)
BASEMENT WINDOW
BEAM POCKET
BASEMENT
4" CONC. SLAB OVER 6 MIL. VAPOR BARRIER OVER 4" CR. STONE
3 1/2" DIA. ADJ. STEEL TUBE COLUMN ON 3'-0" SQ. X 2'-0" CONCRETE FOOTING
3 1/2" DIA. ADJ. STEEL TUBE COLUMN ON 2'-0" SQ. X 1'-0" CONCRETE FOOTING (TYPICAL)
PORCH SLAB
4" CONCRETE SLAB ON 4" CRUSHED STONE
2" LEDGE FOR PORCH SLAB SUPPORT
CONC. HAUNCH
DROP 7" FOR PORCH STEP
RADON SUMP
RADON VENT
FDN. FOR OPT. FIREPLACE
36" H. RAILING BALLISTERS SPACED SO 4" SPHERE MAY NOT PASS THRU.
GARAGE
4" CONC. SLAB W/ W 1.4 x W1.4 WWF ON 6 MIL VAPOR BARRIER ON 4" CRUSHED STONE
SLOPE 1/4" PER FOOT
NOTE:
FOOTING SIZES ARE AS FOLLOWS:
12" FDN. WALL = 12" x 24" FTG.
10" FDN. WALL = 10" x 20" FTG.
8" FDN. WALL = 8" x 20" FTG.
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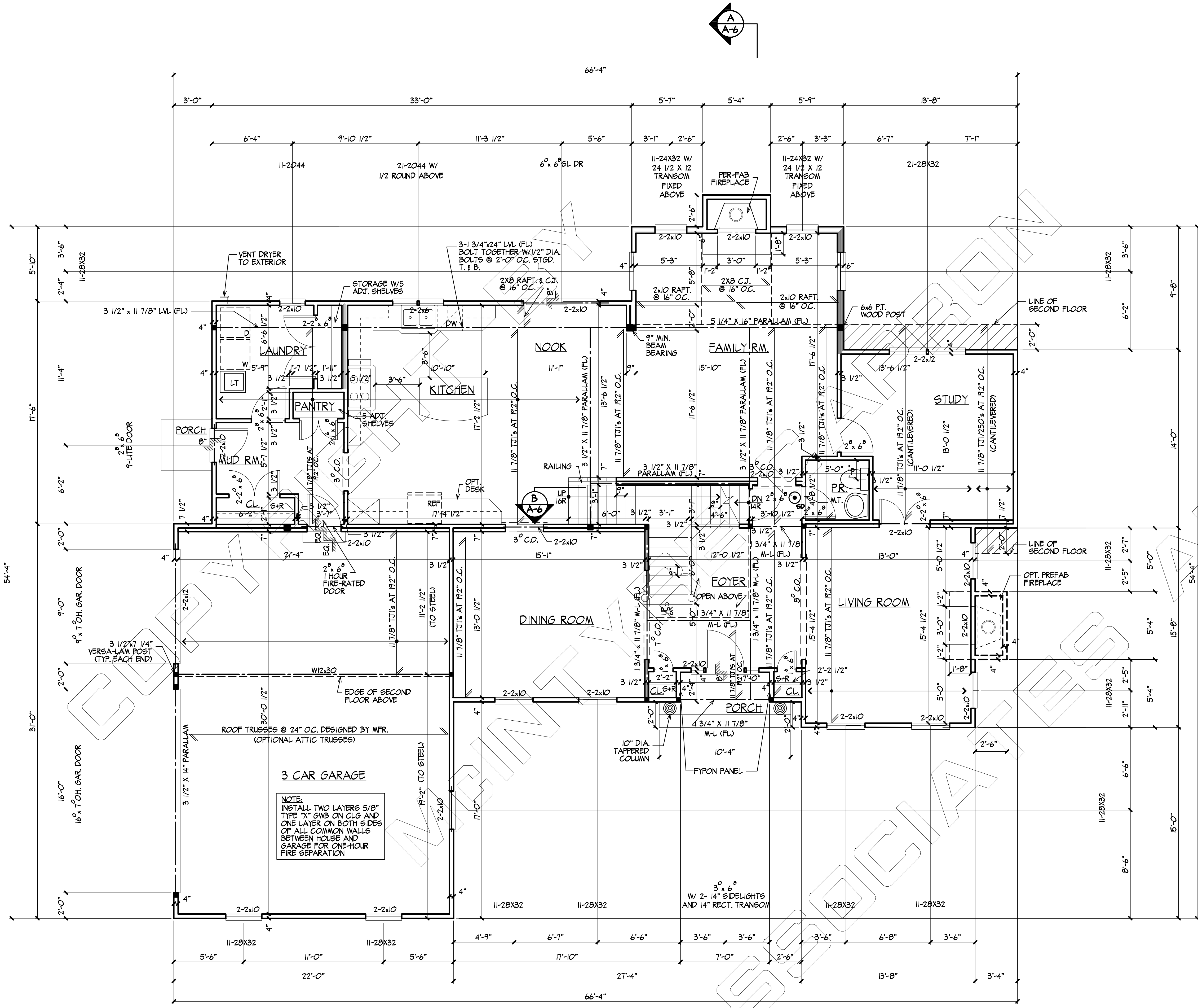

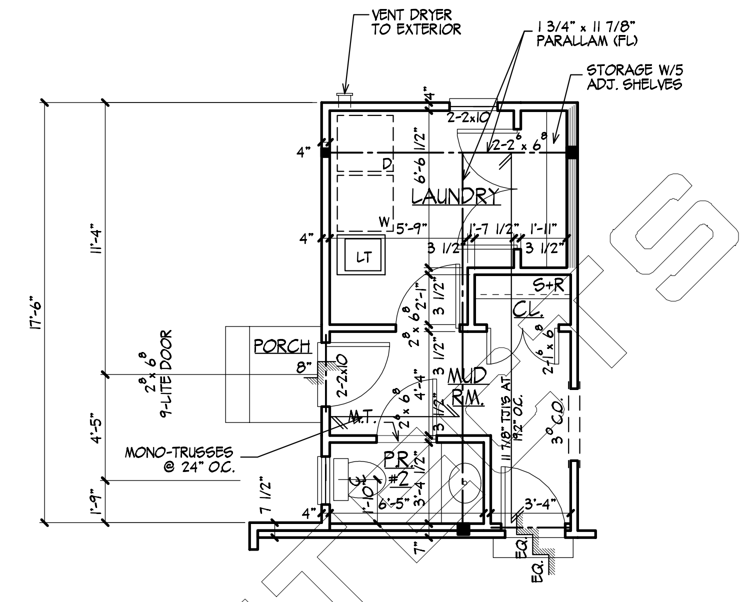

OPTIONAL POWDER ROOM

SCALE: 1/4" = 1'-0"

FIRST FLOOR PLAN

SCALE: 1/4" = 1'-0"

SQUARE FOOTAGE TOTALS	
FIRST FLOOR	1,750.00 SQ. FT.
SECOND FLOOR	1,557.00 SQ. FT.
TOTAL	3,307.00 SQ. FT.

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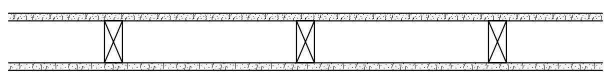
GA FILE NO. WP 3510 — 1 HOUR



GYPSUM WALLBOARD, WOOD STUDS

ONE LAYER 5/8" TYPE "X" GYPSUM WALLBOARD OR VENEER BASE APPLIED PARALLEL WITH OR AT RIGHT ANGLES TO EACH SIDE OF 2 X 4 WOOD STUDS SPACED 24" O.C. MAX. WITH 6D COATED NAILS 1 7/8" LONG, 0.0915" SHANK, 1/4" HEADS, 7" O.C. WALLBOARD NAILED TO TOP AND BOTTOM PLATES AT 7" O.C. STAGGER JOINTS 24" O.C. EACH SIDE. (LOAD-BEARING)

FIRE TEST: UL R3501-47, -48, 9-17-65,
DESIGN U309
UL R1319-129, 7-22-70
DESIGN U314

1-HOUR INTERIOR WALL DETAIL

1/A2a SCALE: 1 1/2" = 1'-0"

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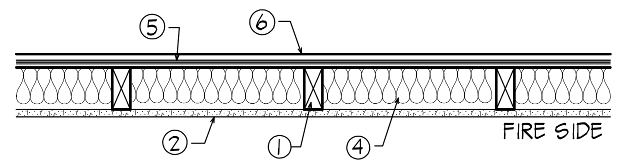
DESIGN #U356 — 1 HOUR



1. WOOD STUDS - NOM. 2 BY 4 IN. SPACED 16 IN. OC WITH TWO 2 BY 4 IN(NOM) TOP PLATES AND ONE 2 BY 4 IN.(NOM) BOTTOM PLATE. STUDS LATERALLY-BRACED BY WOOD STRUCTURAL PANEL SHEATHING(ITEM 5) AND EFFECTIVLY FIRE STOPPED AT TOP AND BOTTOM OF WALL.
2. WALLBOARD, GYPSUM* - ANY CLASSIFIED 5/8 IN. THICK, 4 FT. WIDE, APPLIED VERTICALLY AND NAILED TO STUDS AND BEARING PLATES 7 IN. OC WITH 6D CEMENT-COATED NAILS, 1 7/8 IN. LONG WITH 1/4 IN. DIA. HEAD.
SEE WALLBOARD, GYPSUM (CKNX) CATAGORY FOR NAMES OF CLASSIFIED COMPANIES..
3. JOINTS AND NAILHEADS - (NOT SHOWN) - WALLBOARD JOINTS COVERED WITH TAPE AND JOINT COMPOUND, NAILHEADS COVERED WITH JOINT COMPOUND.
4. BATTS AND BLANKETS* - MINERAL FIBER OR GLASS FIBER INSULATION, 3-1/2 IN. THICK, PRESSURE FIT TO FILL WALL CAVITIES BETWEEN STUDS AND PLATES. MINERAL FIBER INSULATION TO BE UNFACED AND TO HAVE A MIN. DEN. OF 3PCF. GLASS FIBER INSULATION TO BE FACED WITH ALUMINUM FOIL OR KRAFT PAPER AND TO HAVE MIN. DEN. OF 0.9 PCF (MIN. R-13 THERMAL INSULATION RATING)
SEE BATTS AND BLANKETS (BKNV) CATEGORY IN THE BUILDING MATERIALS DIRECTORY AND BATTS AND BLANKETS (BZJZ) CATEGORY IN THE FIRE RESISTANCE DIRECTORY FOR NAMES OF CLASSIFIED COMPANIES.
5. WOOD STRUCTURAL PANEL SHEATHING - MIN. 7/16 IN. THICK, 4 FT. WIDE APA RATED SHEATHING EXPOSURE 1, PLYWOOD OR ORIENTED STRAND BOARD (OSB) PER PS 1, PS 2, OR APA STANDARD PRP-108. INSTALLED WITH LONG DIMENSION OF SHEET(STRENGTH AXIS) OR FACE GRAIN OF PLYWOOD PARALLEL WITH OR PERPENDICULAR TO WALL STUDS. VERTICAL JOINTS CENTERED ON STUDS. HORIZONTAL JOINTS BACKED WITH NOM. 2 BY 4 IN. WOOD BLOCKING. ATTACHED TO STUDS ON EXTERIOR SIDE OF WALL WITH 6D CEMENT COATED BOX NAILS SPACED 6 IN. OC AT PERIMETER OF PANELS AND 12 IN. OC ALONG INTERIOR STUDS.
6. EXTERIOR FACINGS - INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S INSTALLATION INSTRUCTIONS.

1-HOUR EXTERIOR WALL DETAIL

2/A2a SCALE: 1 1/2" = 1'-0"

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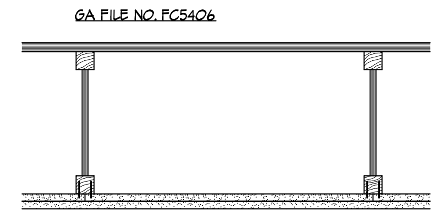
GA FILE NO. FC5406



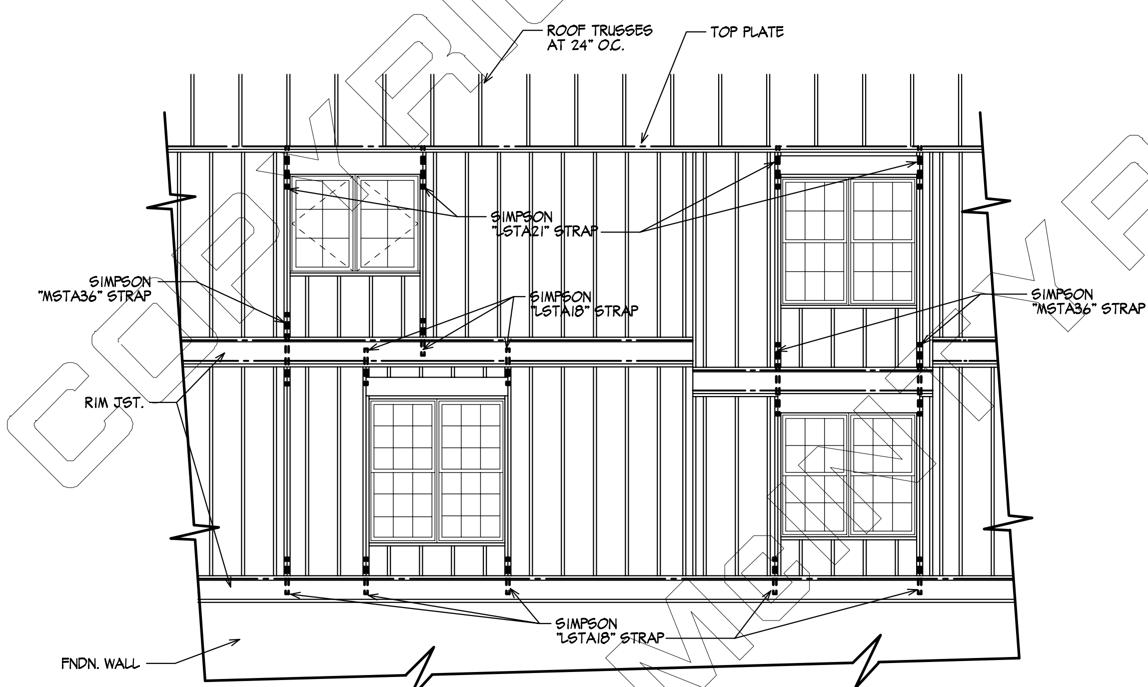
1- HOUR FLOOR / CEILING ASSEMBLY

3/A2a 1 1/2" = 1'-0" t:\moser09\madison.db/plan5.dr 3" = 1'-0"

FIRE TEST: SEE FM FC 172, 2-25-72

BASE LAYER 5/8" TYPE "X" GYPSUM WALLBOARD APPLIED AT RIGHT ANGLES TO 2X10* WOOD JOISTS AT 24" O.C. (MAX) WITH 1 1/4" TYPE "W" OR TYPE "S" DRYWALL SCREWS AT 24" O.C. FACE LAYER 5/8" TYPE "X" GYPSUM WALLBOARD OR GYPSUM VENEER BASE APPLIED AT RIGHT ANGLES TO JOISTS WITH 1 7/8" TYPE "S" DRYWALL SCREWS 12" O.C. AT JOINTS AND INTERMEDIATE JOINTS AND 1 1/2" TYPE "G" DRYWALL SCREWS AT 12" O.C. PLACED 2" BACK ON EITHER SIDE OF END JOINTS. JOINTS OFFSET 24" FROM BASE LAYER JOINTS. WOOD JOIST SUPPORTING 1/2" (MIN) PLYWOOD WITH EXTERIOR GLUE APPLIED AT RIGHT ANGLES TO JOISTS WITH 8D NAILS.

CEILING PROVIDES ONE HOUR FIRE RESISTANCE PROTECTION FOR WOOD FRAMING, INCLUDING TRUSSES AND (*) ENGINEERED WOOD MEMBERS.



CONTINUOUS LOAD PATH AT WALL OPENING - MIN. STRAP REQUIREMENTS

A/A-2a

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SCALE AS NOTED..
TITLE FIRE DETAILS

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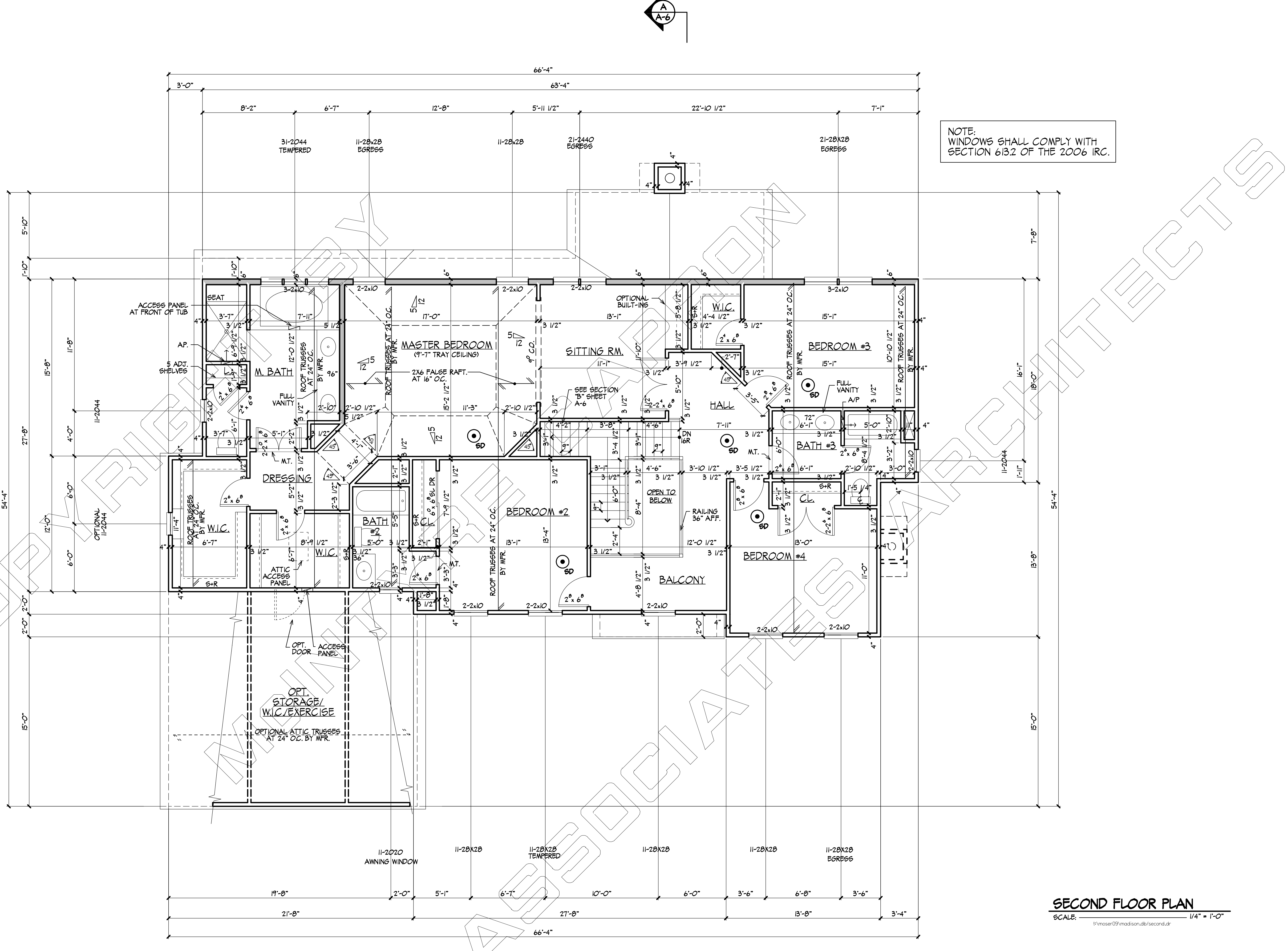

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SCALE 1/4" = 1'-0"
TITLE SECOND FLOOR PLAN

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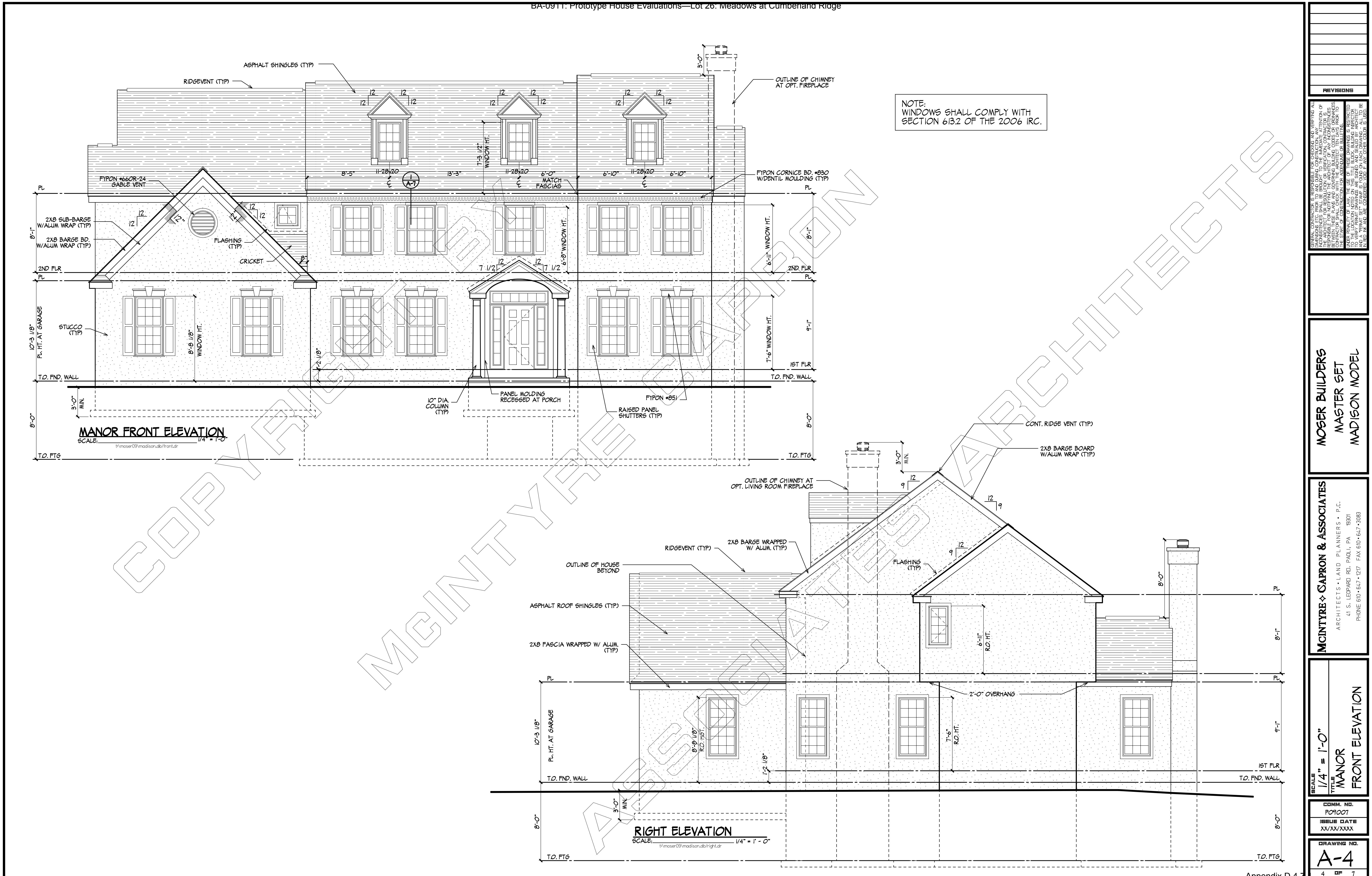
MANOR FRONT ELEVATION
SCALE: 1/4" = 1'-0"
RIGHT ELEVATION
SCALE: 1/4" = 1' - 0"
NOTE:
WINDOWS SHALL COMPLY WITH SECTION 613.2 OF THE 2006 IRC.
ASPHALT SHINGLES (TYP)
RIDGEVENT (TYP)
OUTLINE OF CHIMNEY AT OPT. FIREPLACE
FYPON #660R-24 GABLE VENT
FYPON CORNICE BD. #830 W/DENTIL MOULDING (TYP)
MATCH FASCIAS
2X8 SUB-BARGE W/ALUM WRAP (TYP)
2X8 BARGE BD. W/ALUM WRAP (TYP)
FLASHING (TYP)
CRICKET
STUCCO (TYP)
10" DIA. COLUMN (TYP)
PANEL MOLDING RECESSED AT PORCH
FYPON #851
RAISED PANEL SHUTTERS (TYP)
2ND FLR
1ST FLR
T.O. FND. WALL
T.O. FTG
PL
CONT. RIDGE VENT (TYP)
2X8 BARGE BOARD W/ALUM WRAP (TYP)
OUTLINE OF CHIMNEY AT OPT. LIVING ROOM FIREPLACE
2X8 BARGE WRAPPED W/ ALUM. (TYP)
OUTLINE OF HOUSE BEYOND
ASPHALT ROOF SHINGLES (TYP)
2X8 FASCIA WRAPPED W/ ALUM. (TYP)
2'-0" OVERHANG
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SCALE 1/4" = 1'-0"
TITLE MANOR FRONT ELEVATION
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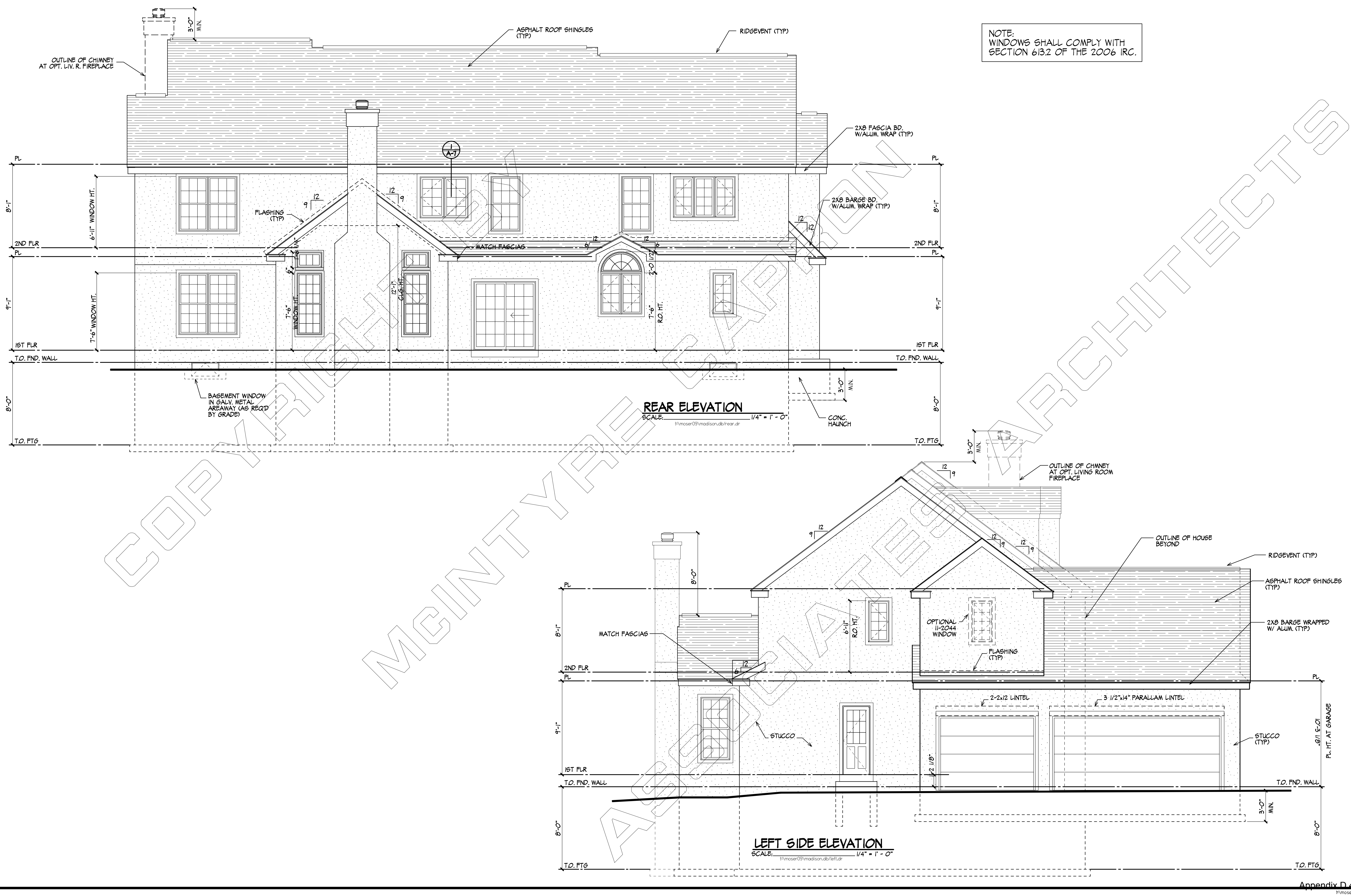

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SCALE 1/4" = 1'-0"
TITLE REAR ELEVATION

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DRAWING NO. A-5
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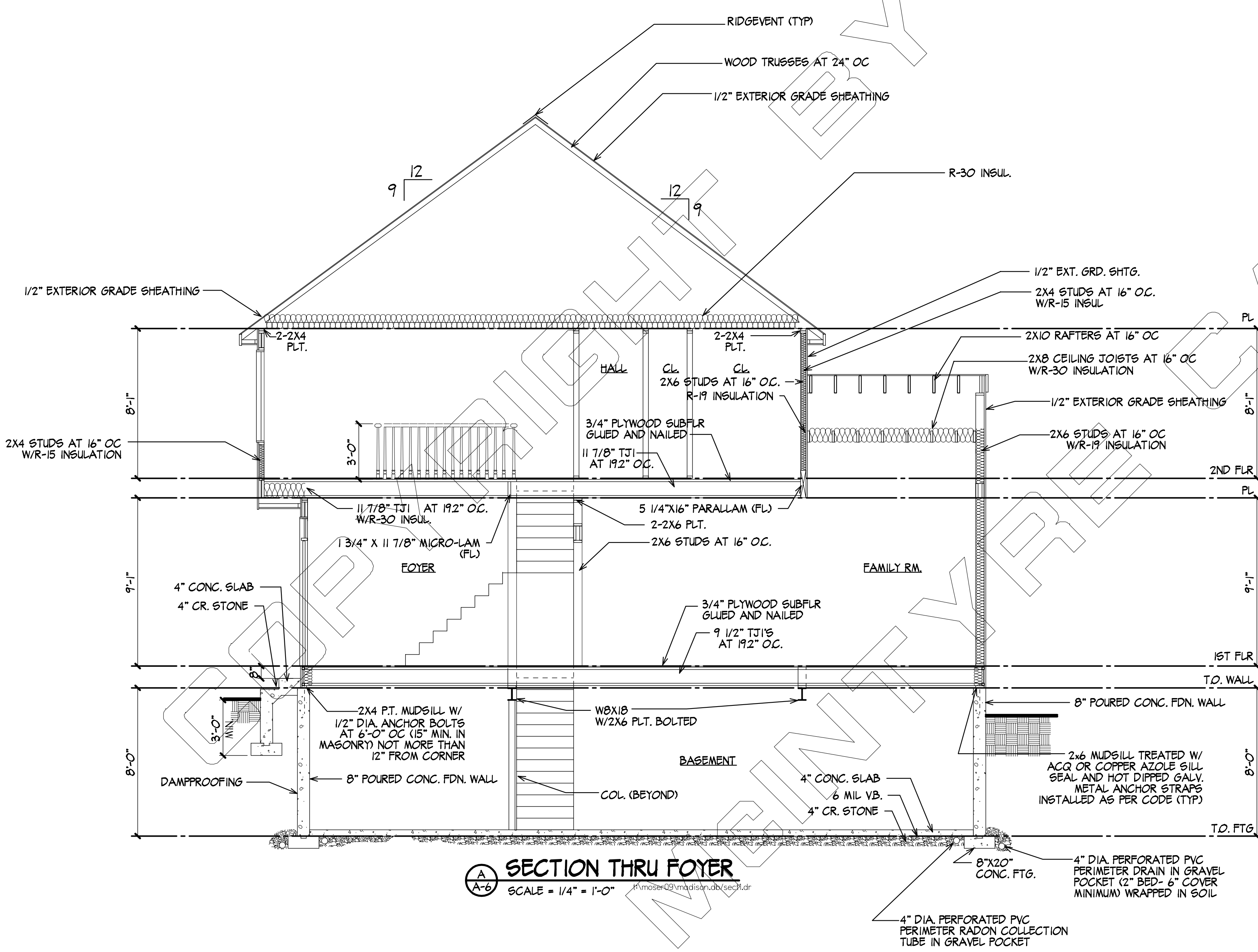

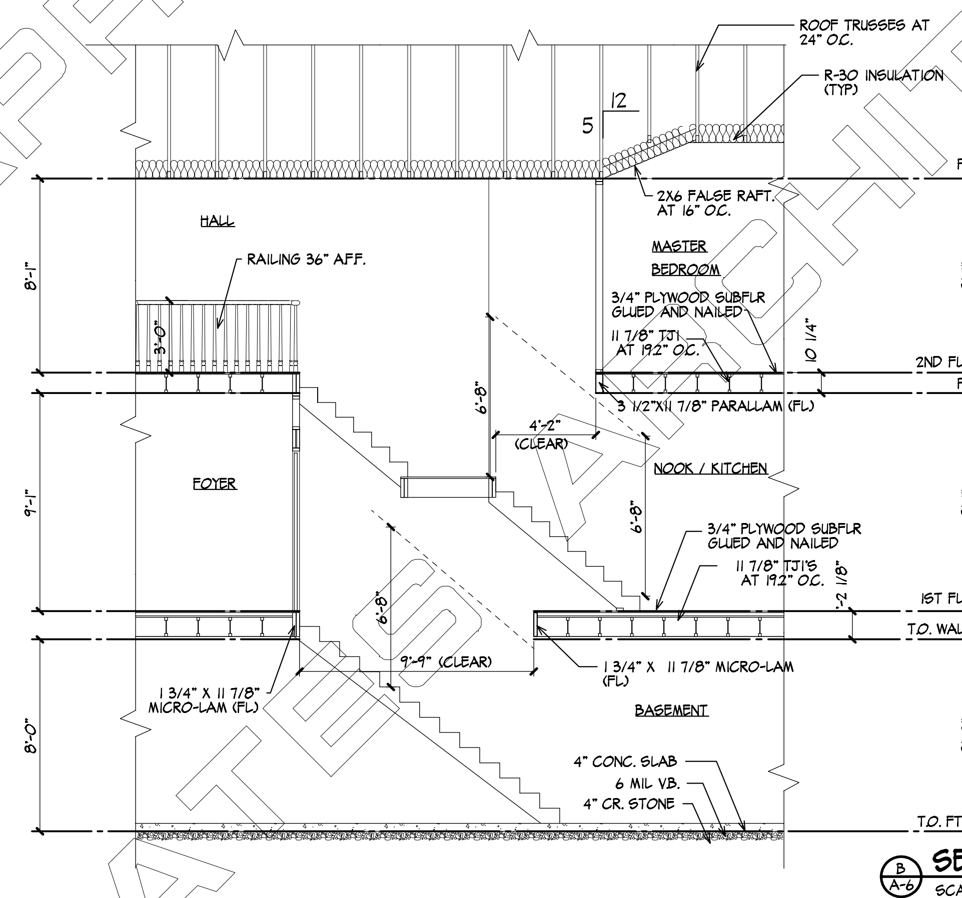

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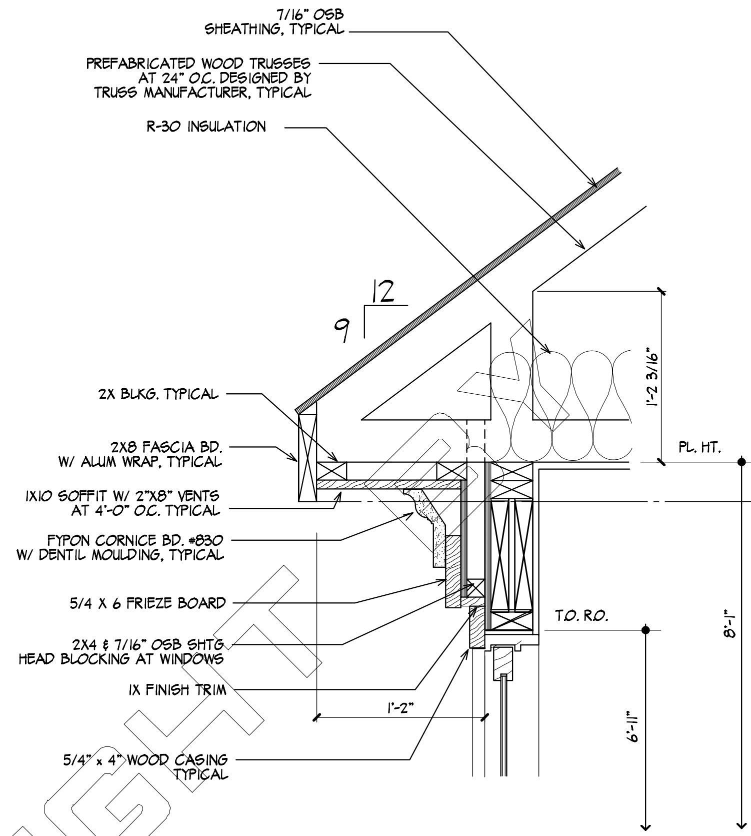
DRAWING NO. A-6
6 OF 7



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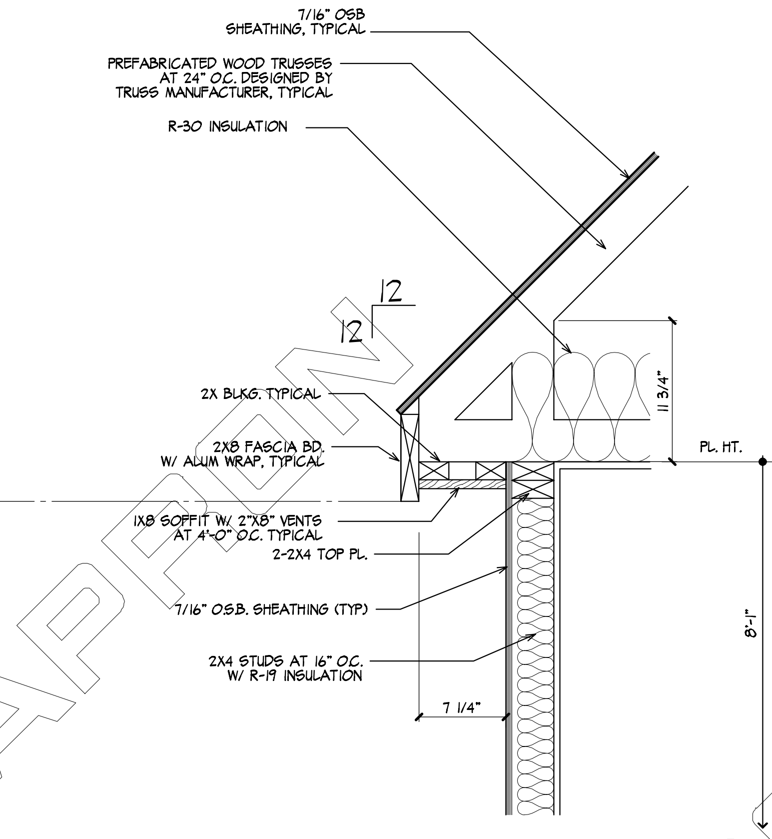

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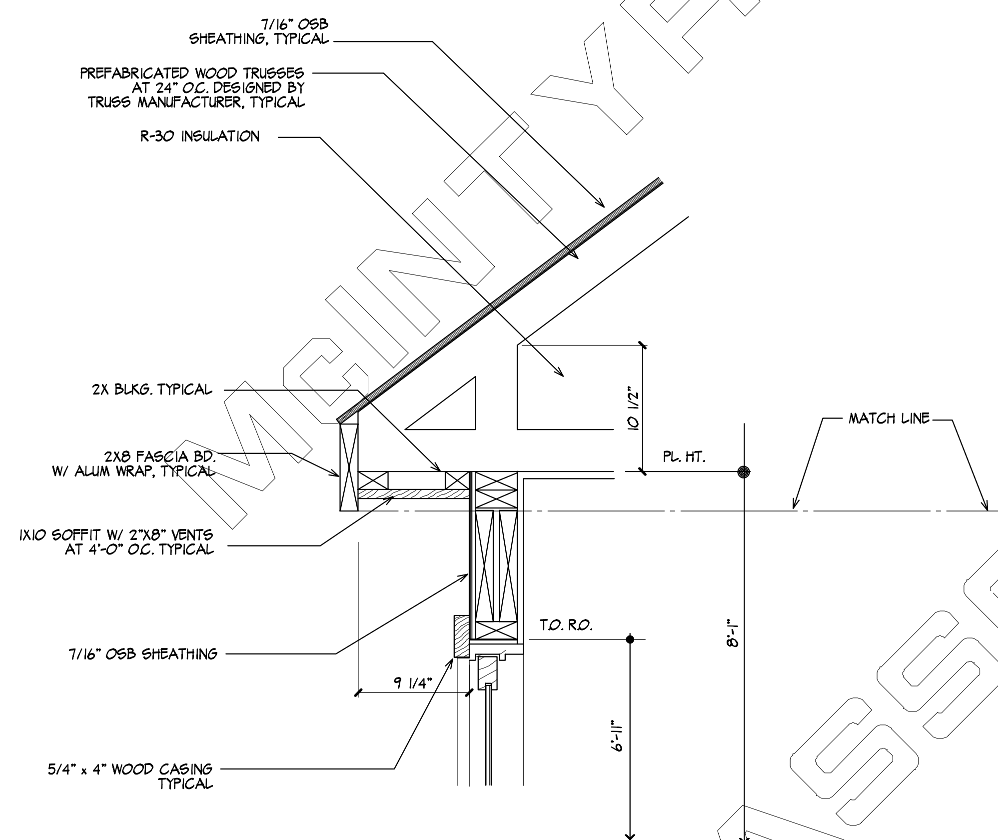

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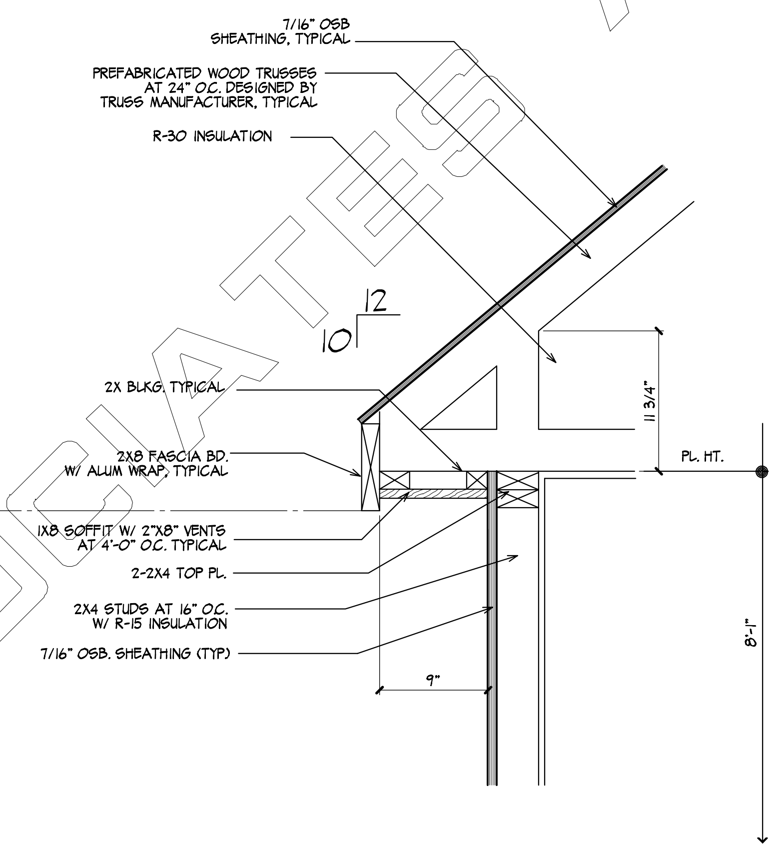

2 A-7 EAVE DETAIL AT 10:12 (ALT. ELEV. #2)
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REVISIONS

GENERAL CONTRACTOR IS RESPONSIBLE FOR CHECKING AND VERIFYING ALL DIMENSIONS ETC. PRIOR TO AND DURING CONSTRUCTION. ANY INCONSISTENCIES SHALL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE ARCHITECT FOR RESOULUTION OR VERIFICATION. CONTRACTOR IS RESPONSIBLE FOR NOTIFYING THE ARCHITECT OF ANY INCONSISTENCIES BETWEEN THESE PLANS AND GOVERNING BUILDING CODES OR ORDINANCES. CONTRACTOR SHALL CHECK WITH THE ARCHITECT TEN DAYS PRIOR TO THE START OF CONSTRUCTION FOR ADDENDUMS OR BULLETINS.

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MOSER BUILDERS
MASTER SET
MADISON MODEL

McINTYRE ◊ CAPRON & ASSOCIATES
ARCHITECTS • LAND PLANNERS • P.C.
41 S. LEOPARD RD. PAOLI, PA 19301
PHONE 610 • 647 • 1217 FAX 610 • 647 • 3083

SCALE 1 1/2" = 1'-0"
TITLE EAVE DETAILS W/ ALUM. FASCIA

COMM. NO. P09007
ISSUE DATE XX/XX/XXXX
DRAWING NO. A-7
7 OF 7

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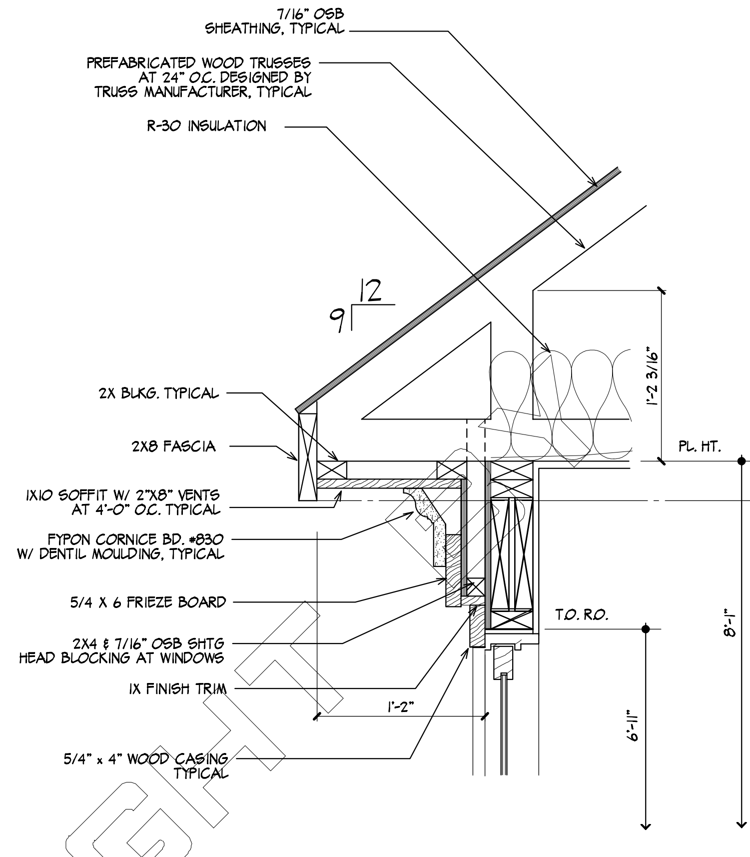

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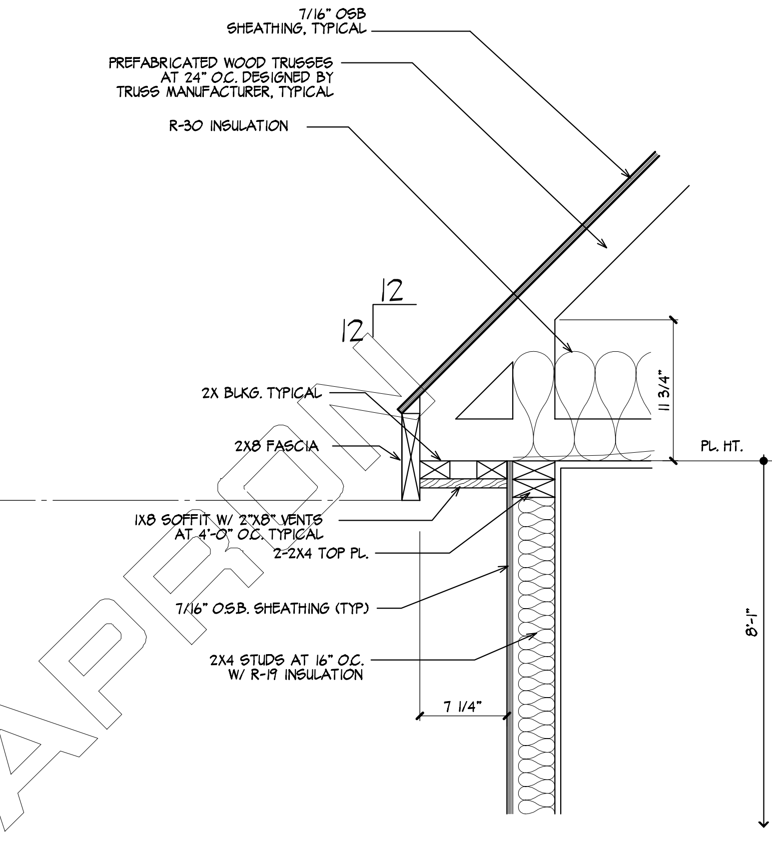

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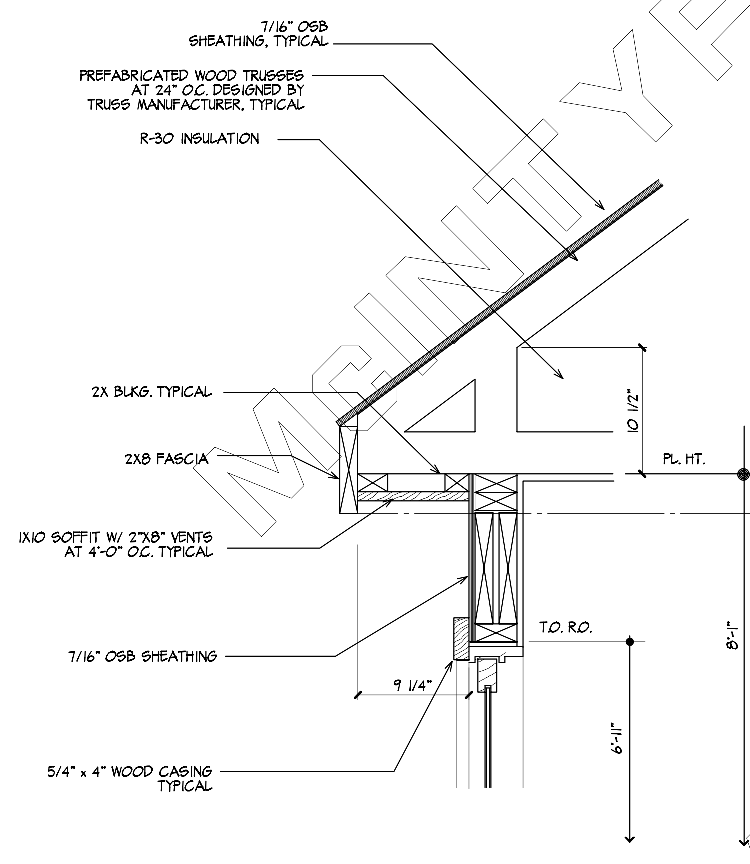

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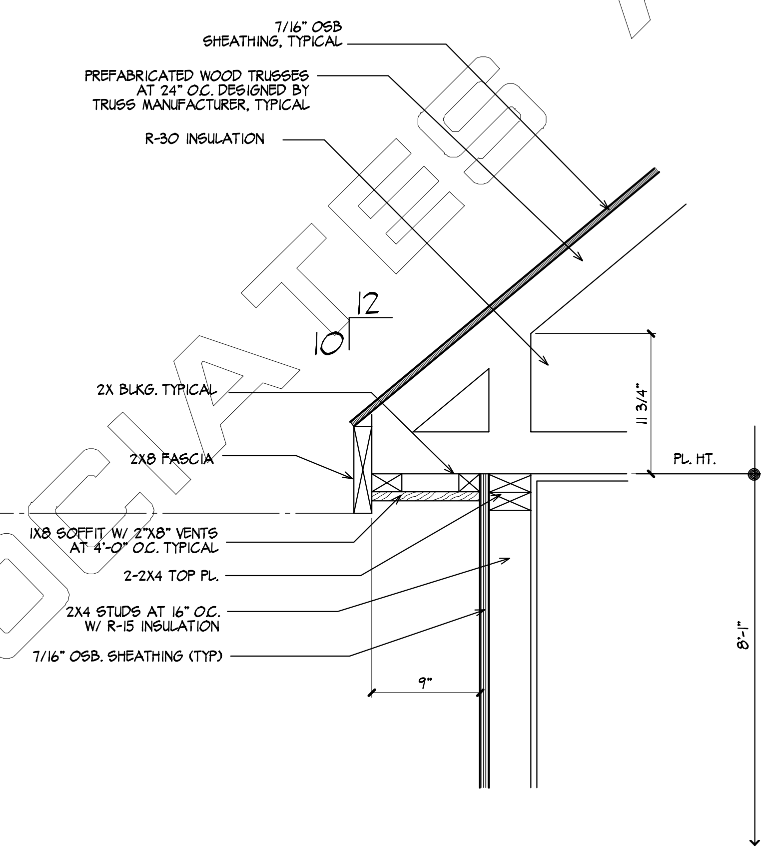

2 A-7 EAVE DETAIL AT 10:12 (ALT. ELEV. #2)
1 1/2" = 1'-0" t:\moser09\madison.db\plan4.dr

REVISIONS

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41 S. LEOPARD RD. PAOLI, PA 19301
PHONE 610 • 647 • 1217 FAX 610 • 647 • 3083

SCALE 1 1/2" = 1'-0"
TITLE EAVE DETAILS W/ WOOD FASCIA

COMM. NO. P09007
ISSUE DATE XX/XX/XXXX
DRAWING NO. A-7a
OF 7

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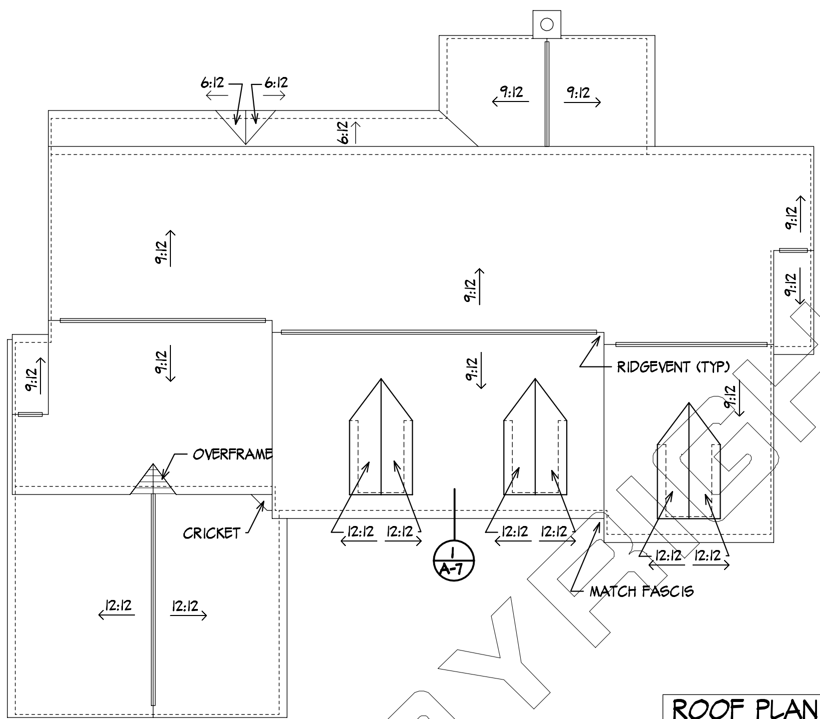
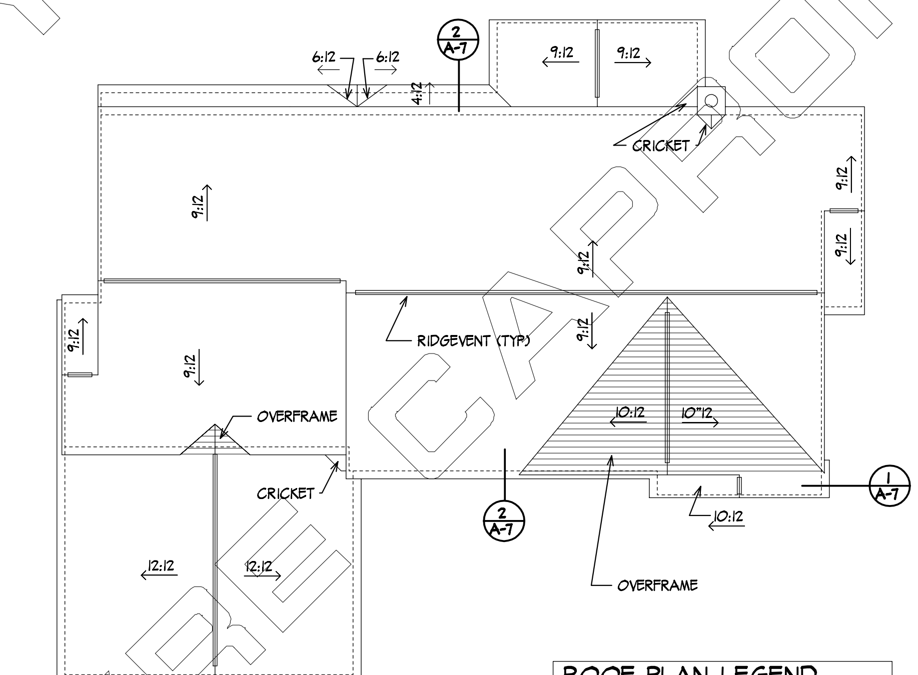


MANOR ROOF PLAN
1/8" = 1' - 0"

ROOF PLAN LEGEND

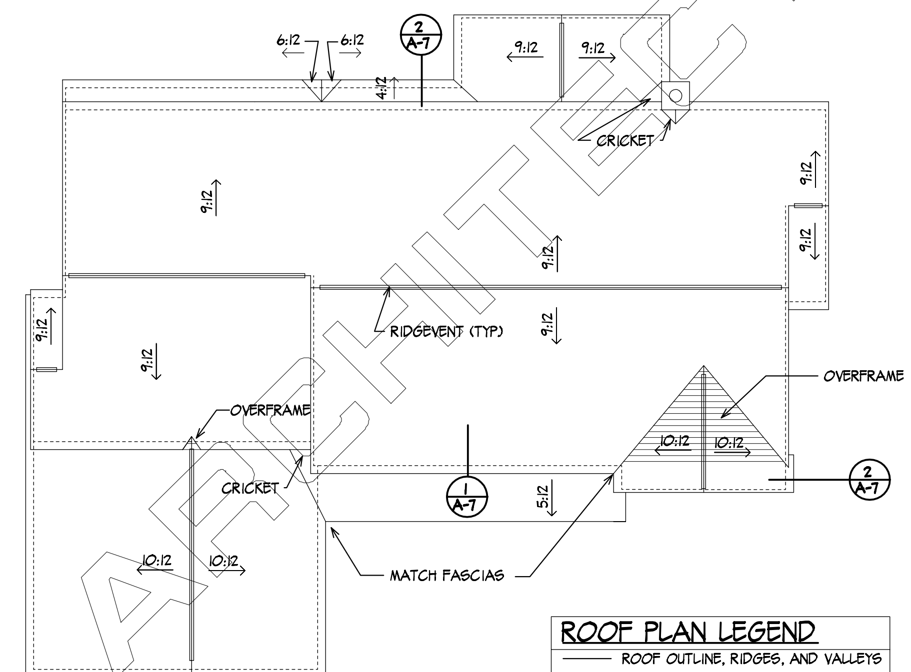
- ROOF OUTLINE, RIDGES, AND VALLEYS
- LINE OF HOUSE BELOW
- 12:12 ROOF PITCH



COTTAGE ROOF PLAN
1/8" = 1' - 0"

ROOF PLAN LEGEND

- ROOF OUTLINE, RIDGES, AND VALLEYS
- LINE OF HOUSE BELOW
- 5" "K" GUTTER
- 4" DIAMETER DOWNSPOUT
- 12:12 ROOF PITCH



ROOF PLAN AT ALT. ELEV. #2
1/8" = 1' - 0"

ROOF PLAN LEGEND

- ROOF OUTLINE, RIDGES, AND VALLEYS
- LINE OF HOUSE BELOW
- 5" "K" GUTTER
- 4" DIAMETER DOWNSPOUT
- 12:12 ROOF PITCH

REVISIONS

MOSER BUILDERS
MASTER SET
MADISON MODEL

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ARCHITECTS • LAND PLANNERS • P.C.
41 S. LEOPARD RD, PAOLI, PA 19301
PHONE 610 • 647 • 1217 FAX 610 • 647 • 3083

SCALE 1/8" = 1'-0"
TITLE ROOF PLAN

COMM. NO. P09007
ISSUE DATE XX/XX/XXXX
DRAWING NO. A-8
8 OF 7

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Appendix D.4.7.2
Lateral Bracing Design

2009.05.25

Ted Moser
Moser Builders, Inc.
1171 Lancaster Avenue
Suite 201
Berwyn, PA 19312
(610) 725-0812
(610) 725-0816 (Fax)

Re: Madison Lateral Bracing Design

Dear Mr. Moser:

We have completed the lateral bracing design for the Madison Plan. For the most part the building bracing design fits under the prescriptive requirements of the both the 2006 IRC as well as the new requirements under the 2009 IRC. A few locations will need to be reviewed by your structural engineer as the geometry of the home does not fit into the prescriptive portion. These areas will be highlighted in this letter along with some discussion on the topic.

The plans were reviewed and the bracing design completed to meet the prescriptive requirements for both the 2003/2006 IRC as well as the 2009 IRC. While we know that the 2009 IRC is not currently adopted in Pennsylvania, we would recommend that the 2009 be followed as the significant changes that were made in the code provide in our opinion a more logical bracing design. I have also provided for your reference the appropriate code sections from both the 2006 IRC as well as the 2009 IRC, as well as a CAD file of the bracing layout so that window position and wall panel placements can be verified.

After you have reviewed the analysis and design, please feel free to contact me with any questions that you may have.

Sincerely,

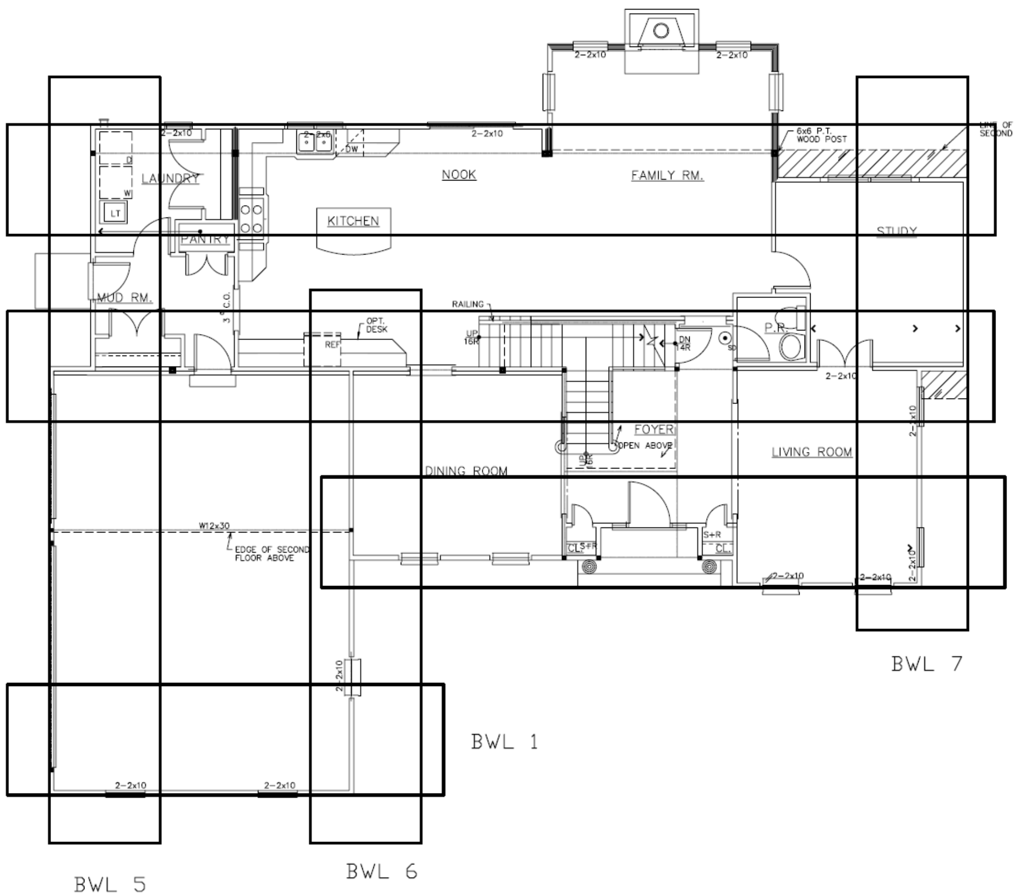
Peter Baker, P.Eng.
Building Science Corporation

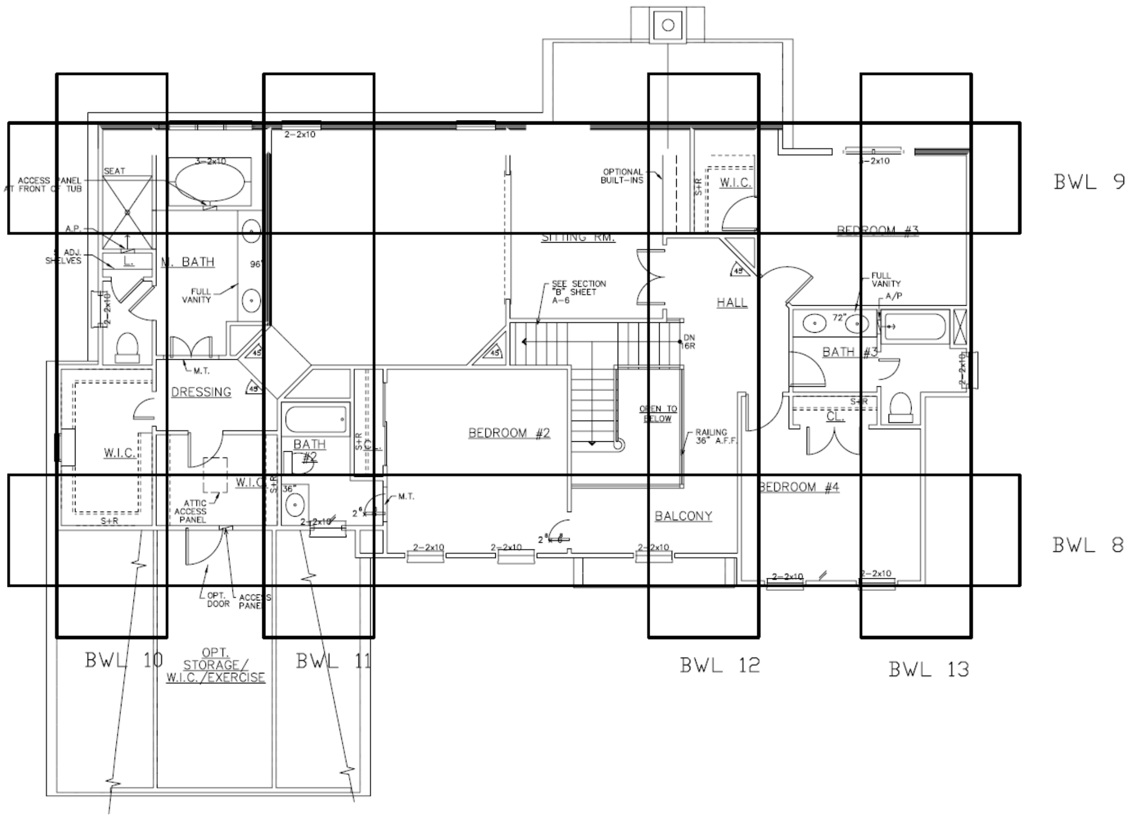
CC: Betsy Pettit, FAIA — Building Science Corporation
Joseph W. Lstiburek, Ph.D., P.Eng. — Building Science Corporation

Attach: 2009 IRC Section R602.10 Wall Bracing (excerpt)
2006 IRC Section R602.10 Wall Bracing (excerpt)
2006 IRC Table R301.2.2.2.1 Wall Bracing Adjustment Factors
2005_05_25 Madison Lateral Bracing.dwg

Braced Wall Lines

The first and second floor plans were examined to determine the most appropriate location for braced wall lines. Each braced wall line is designated by a box which allows for a maximum 8 foot offset. The centerline of each box represents the location of the braced wall line.





Braced Panel Requirements

For each braced wall line a specific amount of braced wall panels need to be installed to provide for the lateral bracing. The following tables summarize the prescriptive required amount of wall bracing based on the 2009 IRC as well as the 2006 IRC.

First Floor

2009 IRC Requirements

Braced Wall Line Number	1	2	3	4	5	6	7
Type of bracing	WSP	WSP	GB	WSP	PFG	WSP	CS
Measured Spacing (ft)	15	15	14	14	18	39	39
Table R602.10.1.2(1) - Spacing of BWL (ft)	20	20	20	20	20	40	40
Table R602.10.1.2(1) - Supporting	roof	2nd	2nd	2nd	2nd	2nd	2nd
Table R602.10.1.2(1) - Bracing Requirement (ft)	5.5	7.5	13	7.5	7.5	14	12
Adjustment Factors (footnotes a through i)							
b. Exposure/Height Factors	*1*	*1*	*1*	*1*	*1*	*1*	*1*
c. Roof Eave to Ridge Height	*1.15*	*1.15*	*1.15*	*1.15*	*1.15*	*1.15*	*1.15*
d. Wall Height	*0.95*	*0.95*	*0.95*	*0.95*	*0.95*	*0.95*	*0.95*
e. Number of Braced Wall Lines	*1.45*	*1.45*	*1.45*	*1.45*	*1.3*	*1.3*	*1.3*
f. Bracing Method	*1*	*1*	*1*	*1*	*1*	*1*	*1*
Total Required (ft)	**8.7 ft**	**11.9 ft**	**20.6 ft**	**11.9 ft**	**10.7 ft**	**19.9 ft**	**17.0 ft**

Second Floor

2009 IRC Requirements

Braced Wall Line Number	8	9	10	11	12	13
Type of bracing	WSP	WSP	WSP	GB	GB	WSP
Measured Spacing (ft)	26	26	15	27	27	17
Table R602.10.1.2(1) - Spacing of BWL (ft)	30	30	20	30	30	20
Table R602.10.1.2(1) - Supporting	roof	roof	roof	roof	roof	roof
Table R602.10.1.2(1) - Bracing Requirement (ft)	5.5	5.5	4	9.5	9.5	4
Adjustment Factors (footnotes a through i)						
b. Exposure/Height Factors	1	1	1	1	1	1
c. Roof Eave to Ridge Height	1.075	1.075	1.075	1.075	1.075	1.075
d. Wall Height	0.9	0.9	0.9	0.9	0.9	0.9
e. Number of Braced Wall Lines	1	1	1.45	1.45	1.45	1.45
f. Bracing Method	1	1	1	1	1	1
Total Required (ft)	**5.3 ft**	**5.3 ft**	**5.6 ft**	**13.3 ft**	**13.3 ft**	**5.6 ft**

2006 IRC Requirements (<= 100mph)

Braced Wall Line Number	1	2	3	4	5	6	7
R602.10.3 Method of bracing	3	3	5	3	3	Mixed	3
Measured Spacing (ft)	15	15	14	14	18	39	39
Measured Length (ft)	67	67	67	67	49	49	49
R602.10.1.1 Spacing factor	1.00	1.00	1.00	1.00	1.00	1.11	1.11
Table R602.10.1 - Wall Bracing - % of Wall Length	0.16	0.16	0.16	0.16	0.16	0.25	0.16
Table R301.2.2.2.1 - Roof Dead Load Factor	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Calculated Bracing Requirement (ft)	**11.8 ft**	**11.8 ft**	**11.8 ft**	**11.8 ft**	**8.6 ft**	**15.0 ft**	**9.6 ft**

2006 IRC Requirements (<= 100mph)

Braced Wall Line Number	8	9	10	11	12	13
R602.10.3 Method of bracing	3	3	3	5	5	3
Measured Spacing (ft)	26	26	15	27	27	17
Measured Length (ft)	67	67	34	34	34	34
R602.10.1.1 Spacing factor	1.00	1.00	1.00	1.00	1.00	1.00
Table R602.10.1 - Wall Bracing - % of Wall Length	0.16	0.16	0.16	0.25	0.25	0.16
Table R301.2.2.2.1 - Roof Dead Load Factor	1.2	1.2	1.2	1.2	1.2	1.2
Calculated Bracing Requirement (ft)	**12.9 ft**	**12.9 ft**	**6.5 ft**	**10.2 ft**	**10.2 ft**	**6.5 ft**

Wall Bracing Design

The following is a summary of the bracing design. Please refer to the following tables and elevations for bracing method and locations. Not all bracing can be shown on the wall elevations as some interior braced wall lines are also necessary. Please see discussion below for more information on complete bracing design.

First Floor

Bracing Design
(see layout on CAD file)

Braced Wall Line Number	1	2	3	4	5	6	7
Type of bracing	WSP	WSP	GB	WSP	PFH	WSP	CS
Panel width (ft)	4	4	4	4		4	
Number of Panels	3	3	7	4		5	
Total (ft)	**12.0 ft**	**12.0 ft**	**28.0 ft**	**16.0 ft**	**13.0 ft**	**20.0 ft**	**19.0 ft**

2009 IRC Compliance	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
bracing amount over requirement (ft)	3.3	0.1	7.4	4.1	2.3	0.1	2.0

2006 IRC Compliance	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
bracing amount over requirement (ft)	0.2	0.2	16.2	4.2	4.4	5.0	9.4

Second Floor

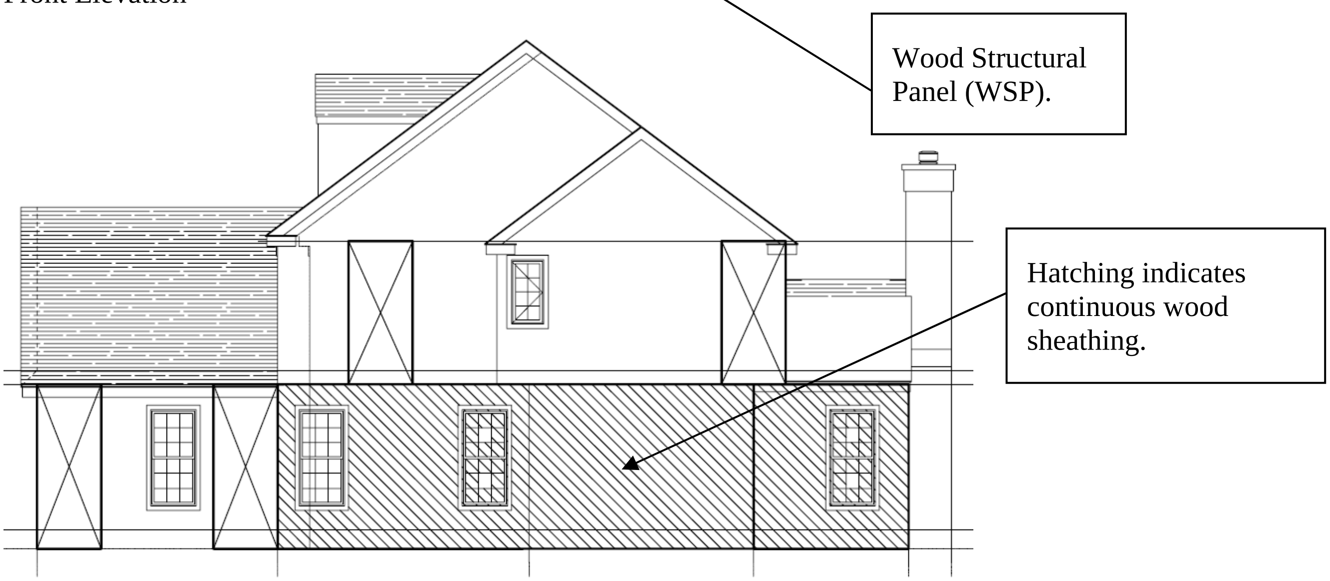
Bracing Design
(see layout on CAD file)

Braced Wall Line Number	8	9	10	11	12	13
Type of bracing	WSP	WSP	WSP	GB	GB	WSP
Panel width (ft)	4	4	4	4	4	4
Number of Panels	4	4	2	5	5	2
Total (ft)	**16.0 ft**	**16.0 ft**	**8.0 ft**	**20.0 ft**	**20.0 ft**	**8.0 ft**

2009 IRC Compliance	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
bracing amount over requirement (ft)	10.7	10.7	2.4	6.7	6.7	2.4

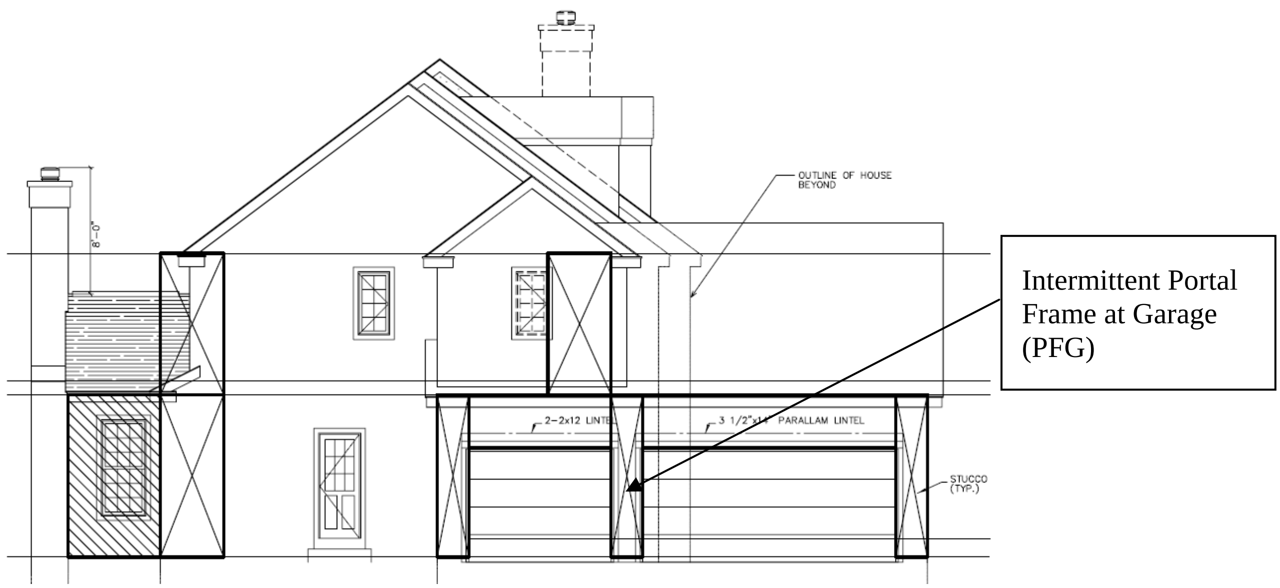
2006 IRC Compliance	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
bracing amount over requirement (ft)	3.1	3.1	1.5	9.8	9.8	1.5

Front Elevation



Right Elevation

Rear Elevation



Left Elevation

For most of the braced wall lines, the bracing is provided by wood structural panels (WSP). This is typical for exterior wall lines. The locations of the WSP are shown on the exterior elevations below. Please refer to ***Table R602.3 (3) of the 2009 IRC*** for attachment requirements.

While most of the bracing design relies on WSP, there are a few exceptions:

BWL 2 - This wall may need to be reviewed by your structural engineer as it meets the prescriptive requirements of the 2009 IRC but does not necessarily meet the requirements of the

2003/2006 IRC. The typical prescriptive requirement is that the wall bracing begin within 12.5 feet of the end of the braced wall line. Given the depth of the garage, the design does not meet the prescriptive requirements of the 2003/2006 IRC. This is a requirement that is in place more from tradition than from engineering. The bracing can begin further away provided that there is a means to transfer the load and that the minimum bracing requirement is still met.

It appears as though this requirement was addressed in the new 2009 IRC, by allowing for braced wall lines to terminate at a perpendicular braced wall line and not the exterior of the building.

R602.10.1 Braced wall lines*. Braced wall lines shall be provided in accordance with this section. The length of a braced wall line shall be measured as the distance between the ends of the wall line. The end of a braced wall line shall be considered to be either:*

1. *The intersection with the perpendicular exterior walls or projection thereof;*
2. *The intersection with perpendicular braced wall lines.*

The minimum bracing is maintained because the amount of bracing is no longer based on a percentage of the braced wall length, but rather on the spacing between the braced wall lines.

BWL 5 – This wall uses an alternate method described as Intermittent Portal Frame at Garage (PFG). Please refer to ***Section R602.10.3.4 of the 2009 IRC*** for panel design and attachment requirements.

BWL 6 – This wall may need to be reviewed by your structural engineer. Similar to BWL 2, it meets the prescriptive requirements of the 2009 IRC but does not necessarily meet the requirements of the 2003/2006 IRC. In this case however; in order to meet the minimum prescriptive requirements for the 2009 IRC, gypsum wall board could not be used as there is insufficient wall area to meet the minimum amount of bracing. To address this, WSP needs to be used instead. The current design uses 5 WSP to provide the bracing (2 exterior of the garage wall, and three lining the garage wall opposite the dining room. The wall terminates perpendicular to BWL 3.

BWL 7 – Given the relatively short length of wall and the relatively large spacing between braced wall lines, the exterior of the wall needs to be fully sheathed in order to meet the minimum bracing requirements. Please refer to ***Table R602.10.4.1 of the 2009 IRC*** for attachment requirements.

BWL 11 & 12 – These braced wall lines are interior braced wall lines and are reliant on the installation of gypsum on both side of the walls that fall within the braced wall line designation. Please refer to ***Table R602.10.2 of the 2009 IRC*** for attachment requirements.

Family Room Bump Out - Another area that falls just outside of the prescriptive requirements is the small bump out of the family room on the first floor. Given the size and location, it is likely that there is adequate bracing provided by the rest of the home to provide for this area. If warranted, the area could be fully sheathed. Please have your structural engineer review this case.

Appendix D.4.7.3
Energy Analysis

2009.3.20

Ted Moser
Moser Builders, Inc.
1171 Lancaster Avenue
Suite 201
Berwyn, PA 19312
(610) 725-0812
(610) 725-0816 (Fax)

Re: Plan Review and Energy Analysis of Strasburg and Madison Plans

Dear Mr. Moser:

We have completed the energy analysis for the Strasburg and Madison plans of the Windham Estates development in Pennsylvania. The results of the analysis show that the plans have source energy consumption reduction of 51% when compared to the Building America Benchmark Protocol. Based on local utility rates of approximately $0.15/kWh and propane at $2.50/gallon, the estimated annual utility cost for the Strasburg house is $3,813. Compared to the Building America Benchmark house utility cost of $8,300/year this represents an annual utility savings of $4,487 per year. For the Madison design, the estimated annual utility cost is$4,367, representing a savings of $5,056 from the Benchmark. Following is a detailed break down of the analysis and results as well as a discussion on the various attributes of the plan.

Sincerely,

Daniel Bergey
Building Science Corporation

Peter Baker, P.Eng.
Building Science Corporation

Building Plan and Specifications

The three charts below describe the dimensions and performance characteristics of the modeled houses. The proposed enclosure properties, mechanical systems, and load reduction measures were applied to both plans.

Strasburg Dimensions

Floor area (sf)	Surface Area (sf)	Volume (cf)	Beds (ct)	Baths (ct)	Glazing Ratio
3203	8283	41651	4	3.5	14.6%

Madison Dimensions

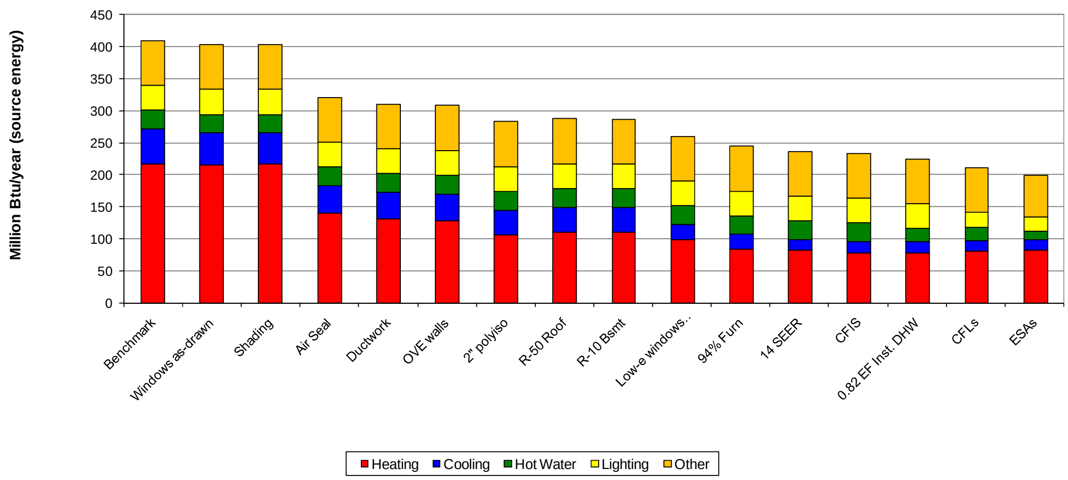
Floor area (sf)	Surface Area (sf)	Volume (cf)	Beds (ct)	Baths (ct)	Glazing Ratio
3782	10574	50314	4	3	13.5%

Building Enclosure	Building America Proposed	Builders Standard Package	Benchmark
Ceiling	vented attic R-50 Blown Cellulose	vented attic R-38 Fiberglass	vented attic R-29
Walls	2" Foil Faced Polyiso (R-13) over 2x6 OVE Framed with R-19 Blown Cellulose	2x4 @ 16" OC w/ R-13 fiberglass batts	2x6 @ 24" OC with R-19 cavity insulation and R-2.3 insulating sheathing
Foundation	Basement R-10 XPS interior	Basement R-11 fiberglass	Basement R-8.4 insulation
Windows	Harvey Industries Tribute Series Triple Pane Lowe-E with Argon U=0.20 SHGC=0.19	Weathershield U=0.35, SHGC = 0.32	U=0.53, SHGC=0.58
Infiltration	2.5 sq in leakage area per 100 sq ft of envelope area	Untested	SLA = 0.00042 (6.1 sq in per 100 sq ft)
Mechanical systems			
Heat	94% AFUE Gas Furnace conditioned space (Basement)	90%+ AFUE Gas Furnace	78% AFUE Gas Furnace
Cooling	14 SEER split system conditioned space	13 SEER split system	10 SEER split system
DHW	0.82 EF Instantaneous gas DHW in conditioned space	direct vent 0.62 EF natural gas water heater	0.53 EF gas water heater
Ducts	R-6 Flex in conditioned space Leak free to out (5% or less)		R-3.3 ducts in basement and conditioned space
Ventilation	Airilaire VCS8126 Supply-only system integrated with AHU 38 CFM continuous average flow	no dedicated system	75 CFM balanced ventilation
Return Pathways	Transfer grilles or jump ducts at bedrooms		
Other Loads			
Lighting	minimum 80% fixtures fitted with CFL bulbs	100% incandescent	14% CFL bulbs
Appliances	Energy Star Dishwasher, Refrigerator, Clotheswasher	Energy Star Dishwasher, Refrigerator, Clotheswasher	Standard Dishwasher, Refrigerator, Clotheswasher

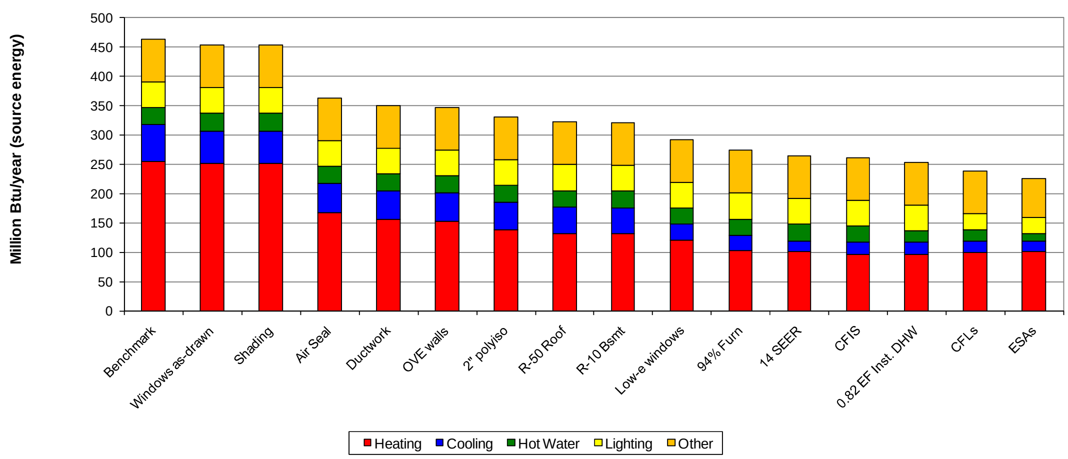
Energy Analysis

Baseline Energy Efficiency Package: A whole house hourly energy consumption parametric simulation was completed comparing the incremental energy consumption reduction for various energy efficiency strategies compared to the Building America Benchmark Protocol created by the Department of Energy. The simulation was run using EnergyGauge USA USRCBB v2.8.01 software developed by the Florida Solar Energy Center (FSEC).

Strasburg Annual Loads



Madison Annual Loads



End Use Site Energy and Source Energy Savings Summary Tables

Strasburg Plan

Table 1. Summary of End-Use Site-Energy

	Annual Site Energy			
	BA Benchmark		Prototype 1	
End-Use	kWh	therms	kWh	therms
Space Heating	1336	1849	474	680
Space Cooling	4674	0	1305	0
DHW	0	268	0	122
Lighting*	3369		2009	
Appliances + Plug	5010	114	4514	115
OA Ventilation**	92		321	
Total Usage	14481	2231	8623	917
Site Generation	0	0	0	0
Net Energy Use	14481	2231	8623	917

*Lighting end-use includes both interior and exterior lighting
**This OA Ventilation energy consumption is for fan energy only, space conditioning is included in Space Heating and Cooling

Table 2. Summary of End-Use Source-Energy and Savings

	Estimated Annual Source Energy		Source Energy Savings	
			Percent of End-Use	Percent of Total
	BA Benchmark	Prototype 1	Prototype 1 savings	Prototype 1 savings
End-Use	106 BTU/yr	106 BTU/yr		
Space Heating	217	80	**63%**	**34%**
Space Cooling	54	15	**72%**	**9%**
DHW	29	13	**54%**	**4%**
Lighting*	39	23	**40%**	**4%**
Appliances + Plug	70	64	**8%**	**1%**
OA Ventilation**	1	4	**-249%**	**-1%**
Total Usage	410	199	**51%**	**51%**
Site Generation	0	0		**0%**
Net Energy Use	410	199	**51%**	**51%**

The "Percent of End-Use" columns show how effective the prototype building is at reducing energy use in each end-use category.
The "Percent of Total" columns show how the energy reduction in each end-use category contributes to the overall savings.

Madison Plan

Table 1. Summary of End-Use Site-Energy

	Annual Site Energy			
	BA Benchmark		Prototype 1	
End-Use	kWh	therms	kWh	therms
Space Heating	1559	2160	583	836
Space Cooling	5500	0	1456	0
DHW	0	268	0	122
Lighting*	3833		2268	
Appliances + Plug	5245	115	4749	115
OA Ventilation**	99		403	
Total Usage	16236	2543	9459	1073
Site Generation	0	0	0	0
Net Energy Use	16236	2543	9459	1073

*Lighting end-use includes both interior and exterior lighting

**This OA Ventilation energy consumption is for fan energy only,
space conditioning is included in Space Heating and Cooling

Table 2. Summary of End-Use Source-Energy and Savings

			Source Energy Savings	
	Estimated Annual Source Energy		Percent of End-Use	Percent of Total
	BA Benchmark	Prototype 1	Prototype 1 savings	Prototype 1 savings
End-Use	106 BTU/yr	106 BTU/yr		
Space Heating	254	98	**61%**	**34%**
Space Cooling	63	17	**74%**	**10%**
DHW	29	13	**54%**	**3%**
Lighting*	44	26	**41%**	**4%**
Appliances + Plug	73	67	**8%**	**1%**
OA Ventilation**	1	5	**-306%**	**-1%**
Total Usage	464	226	**51%**	**51%**
Site Generation	0	0		**0%**
Net Energy Use	464	226	**51%**	**51%**

The "Percent of End-Use" columns show how effective the prototype building is at reducing energy use in each end-use category.

The "Percent of Total" columns show how the energy reduction in each end-use category contributes to the overall savings.

Summary Charts

Moser Builders: Strasburg Plan

ESTIMATED WHOLE HOUSE ENERGY USAGE		
Source (10^6 BTU/yr)	Site (10^6 BTU/yr)	Area + Bsmt (sq ft)
199	121	3203 + 1374
	% Electric	No. of Bedrooms
	24%	4

Moser Builders: Madison Plan

ESTIMATED WHOLE HOUSE ENERGY USAGE		
Source (10^6 BTU/yr)	Site (10^6 BTU/yr)	Area + Bsmt (sq ft)
226	140	3782 + 1747
	% Electric	No. of Bedrooms
	23%	4

Appendix D.4.7.4
Madison Manual J Analysis

Project Report

General Project Information

Project Title:	
Project Date:	Monday, April 20, 2009
Client Name:	Moser Builders
Company Name:	BSC

Design Data

Reference City:		Philadelphia, Pennsylvania
Daily Temperature Range:		Medium
Latitude:	39	Degrees
Elevation:	5	ft.
Altitude Factor:	1.000	
Elevation Sensible Adj. Factor:	1.000	
Elevation Total Adj. Factor:	1.000	
Elevation Heating Adj. Factor:	1.000	
Elevation Heating Adj. Factor:	1.000	

	Outdoor Dry Bulb	Outdoor Wet Bulb	Indoor Rel.Hum	Indoor Dry Bulb	Grains Difference
Winter:	11.6	0	30	72	27
Summer:	92.7	75.6	50	75	41

Check Figures

Total Building Supply CFM:	1,000	CFM Per Square ft.:	0.182
Square ft. of Room Area:	5,505	Square ft. Per Ton:	2,942
Volume (ft³) of Cond. Space:	50,086	Air Turnover Rate (per hour):	1.2

Building Loads

Total Heating Required Including Ventilation Air:	31,310	Btuh	31.310	MBH
Total Sensible Gain:	16,843	Btuh	83	%
Total Latent Gain:	3,507	Btuh	17	%
Total Cooling Required Including Ventilation Air:	20,350	Btuh	1.70	Tons (Based On Sensible + Latent)
			1.87	Tons (Based On 75% Sensible Capacity)

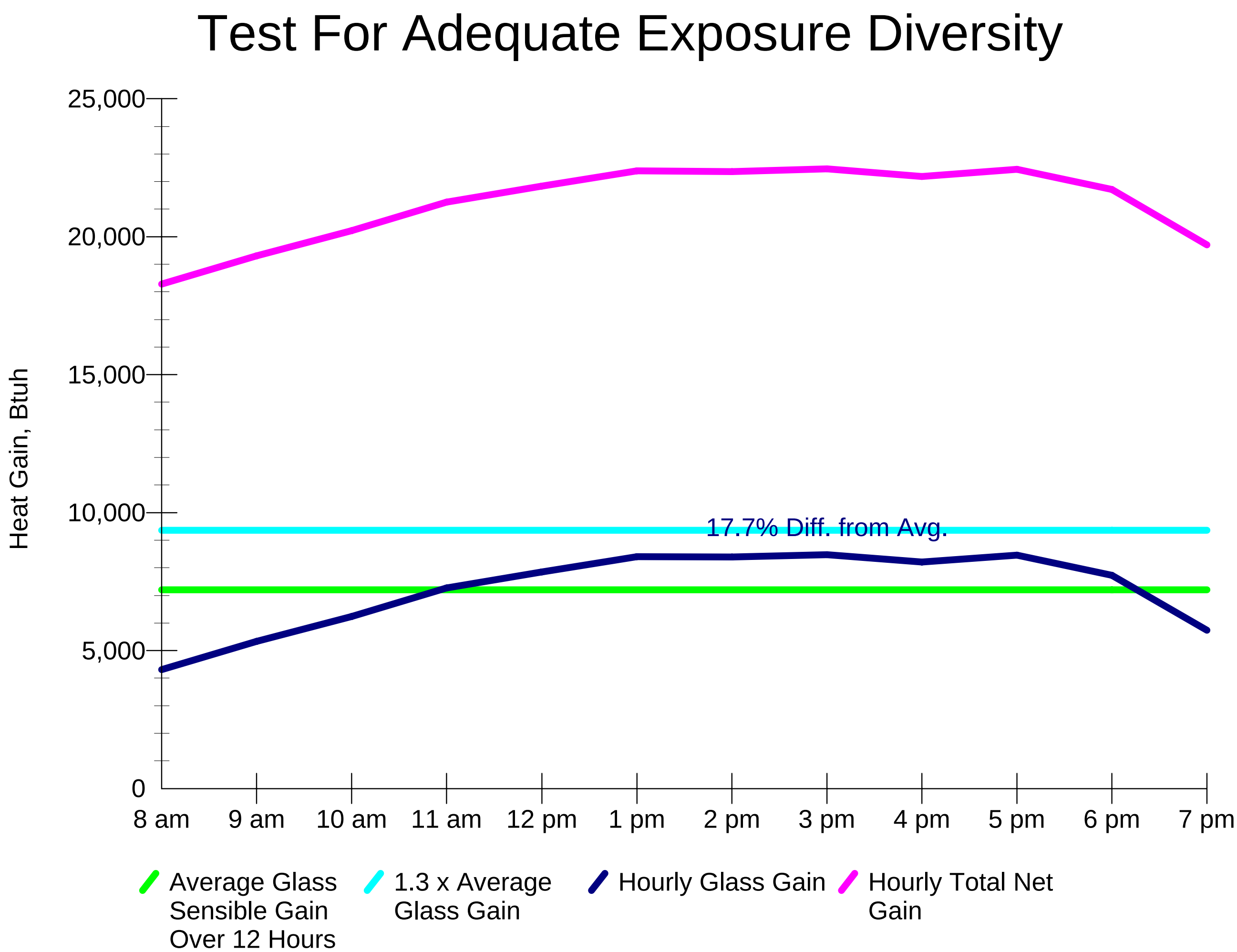
Notes

Calculations are based on 8th edition of ACCA Manual J.
All computed results are estimates as building use and weather may vary.
Be sure to select a unit that meets both sensible and latent loads.

Load Preview Report

Scope	Has AED	Net Ton	Rec Ton	ft.² /Ton	Area	Sen Gain	Lat Gain	Net Gain	Sen Loss	Sys Htg CFM	Sys Clg CFM	Sys Act CFM	Duct Size
Building		1.70	1.87	2,942	5,505	16,843	3,507	20,350	31,310	600	1,000	1,000	
System 1	Yes	1.70	1.87	2,942	5,505	16,843	3,507	20,350	31,310	600	1,000	1,000	14x14
Ventilation						1,460	2,107	3,567	4,982				
Zone 1					3,530	8,480	400	8,880	16,984	387	551	551	9x13
1-Basement					1,776	328	0	328	7,968	182	21	21	1-4
2-Living					214	1,390	0	1,390	1,359	31	90	90	1-6
3-Foyer					199	539	0	539	1,162	26	35	35	1-4
4-Dining					215	628	0	628	920	21	41	41	1-4
5-Study					185	402	0	402	993	23	26	26	1-4
6-Powder					28	0	0	0	0	0	0	0	0-0
7-Family					338	1,745	400	2,145	1,480	34	113	113	1-7
8-Kitchen					381	2,008	0	2,008	1,579	36	131	131	1-7
9-Laundry					90	760	0	760	502	11	49	49	1-5
10-Mudroom					104	680	0	680	1,021	23	44	44	1-5
Zone 2					1,975	6,903	1,000	7,903	9,344	213	449	449	8x12
11-Bedroom4					180	867	200	1,067	1,098	25	56	56	1-5
12-Hall					287	523	0	523	783	18	34	34	1-4
13-Bed2					213	833	200	1,033	854	19	54	54	1-5
14-Bath2					61	186	0	186	389	9	12	12	1-4
15-Bath3					92	363	0	363	451	10	24	24	1-4
16-Bed3					187	790	200	990	1,116	25	51	51	1-5
17-WIC3					40	127	0	127	224	5	8	8	1-4
18-Sitting					180	320	0	320	581	13	21	21	1-4
19-MaBed					327	1,131	400	1,531	1,098	25	74	74	1-6
20-MaBath1					220	546	0	546	1,010	23	35	35	1-4
21-MaBath2					35	299	0	299	295	7	19	19	1-4
22-WIC2					66	398	0	398	652	15	26	26	1-4
23-WIC1					87	520	0	520	793	18	34	34	1-4

System 1 - - Adequate Exposure Diversity Test



AED Calculation Summary

--- SYSTEM HAS ADEQUATE EXPOSURE DIVERSITY. ---

System is on N, E, S, W rosette.
Peak load exceeds 12-hour average load by 17.7%.
AED Excursion (amount by which peak exceeds 1.3 x average): 0 Btuh

Definition: A system has adequate exposure diversity if the peak-hour glass load for the entire conditioned space does not exceed the average glass load for the entire conditioned space by more than 30 percent.

Total Building Summary Loads

Component Description	Area Quan	Sen Loss	Lat Gain	Sen Gain	Total Gain
Harvey Windows: Glazing-Harvey Window, light color drapes with medium weave with 50% coverage, u-value 0.32, SHGC 0.3	33.1	639	0	509	509
H Triple: Glazing-Triple Glazed Harvey Windows, u-value 0.2, SHGC 0.21	429.3	5,184	0	5,314	5,314
Harvey Windows: Glazing-Harvey Window, u-value 0.32, SHGC 0.3	6.4	123	0	73	73
Harvey Patio Door: Glazing-Harvey Low-E Sliding Patio Door, u-value 0.35, SHGC 0.29	40.2	850	0	476	476
11D: Door-Wood - Solid Core	28.2	664	0	316	316
11N: Door-Metal - Polystyrene Core	36.1	674	0	387	387
15B0-10sf-8: Wall-Basement, , R-10 board insulation to floor, no interior finish, 8' floor depth	1945.8	6,330	0	266	266
R-27: Wall-	2879.8	6,610	0	1,741	1,741
R-27: Part-	338.8	688	0	395	395
16B-50: Roof/Ceiling-Under Attic with Insulation on Attic Floor (also use for Knee Walls and Partition Ceilings), Vented Attic, No Radiant Barrier, Dark Asphalt Shingles or Dark Metal, Tar and Gravel or Membrane, R-50 insulation	2125	2,566	0	2,240	2,240
21B-32: Floor-Basement, Concrete slab, any thickness, 2 or more feet below grade, R-3 or higher insulation installed below floor, any floor cover, shortest side of floor slab is 32' wide	1776	1,502	0	0	0
20P-38-c: Floor-Over open crawl space or garage, Passive, R-38 blanket insulation, carpet covering	43.6	79	0	16	16
20P-38-c: Partition Floor (STD=30.7, WTD=53.4)-Over open crawl space or garage, Passive, R-38 blanket insulation, carpet covering	142.1	228	0	131	131
20P-38: Partition Floor (STD=30.7, WTD=53.4)-Over open crawl space or garage, Passive, R-38 blanket insulation, any cover	118.8	191	0	109	109
Subtotals for structure:		26,328	0	11,973	11,973
People:	7		1,400	1,610	3,010
Equipment:			0	1,800	1,800
Lighting:	0			0	0
Ductwork:		0	0	0	0
Infiltration: Winter CFM: 0, Summer CFM: 0		0	0	0	0
Ventilation: Winter CFM: 75, Summer CFM: 75		4,982	2,107	1,460	3,567
Total Building Load Totals:		31,310	3,507	16,843	20,350

Check Figures

Total Building Supply CFM:	1,000	CFM Per Square ft.:	0.182
Square ft. of Room Area:	5,505	Square ft. Per Ton:	2,942
Volume (ft³) of Cond. Space:	50,086	Air Turnover Rate (per hour):	1.2

Building Loads

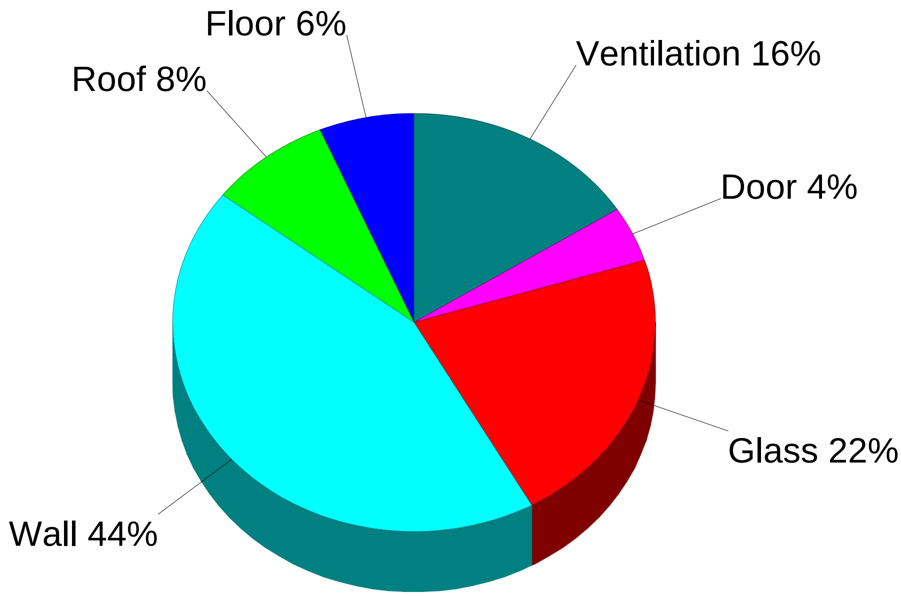
Total Heating Required Including Ventilation Air:	31,310	Btuh	31.310	MBH
Total Sensible Gain:	16,843	Btuh	83	%
Total Latent Gain:	3,507	Btuh	17	%
Total Cooling Required Including Ventilation Air:	20,350	Btuh	1.70	Tons (Based On Sensible + Latent)
			1.87	Tons (Based On 75% Sensible Capacity)

Notes

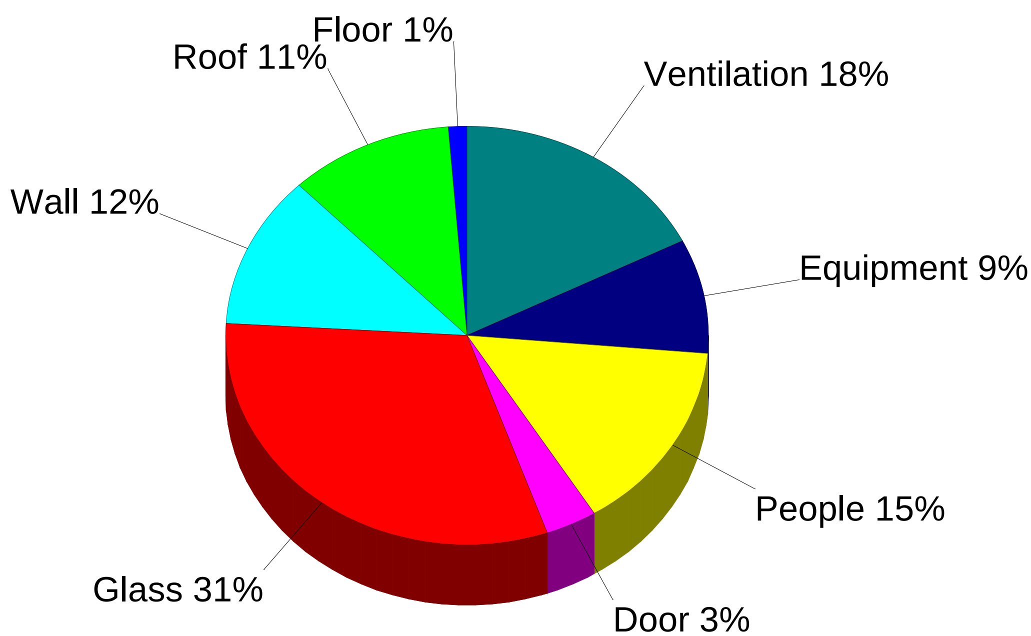
Calculations are based on 8th edition of ACCA Manual J.
All computed results are estimates as building use and weather may vary.
Be sure to select a unit that meets both sensible and latent loads.

Building Pie Chart

Building
Loss
31,310
Btuh



Building
Gain
20,350
Btuh



Building Rotation Report

All rotation degree values in this report are clockwise with respect to the project's original orientation.
Building orientation as entered (zero degrees rotation): Front door faces South
At least one system with its System Air Type input set to Fixed was changed to Auto during the building rotation. If you want to change this behavior uncheck the option on the General tab of the Select Reports dialog called "Always use Auto for System Air Type for Building Rotation Report."

Individual Rooms

Rm. No.	Room Name	0° Rot. CFM	45° Rot. CFM	90° Rot. CFM	135° Rot. CFM	180° Rot. CFM	225° Rot. CFM	270° Rot. CFM	315° Rot. CFM	High Duct Size
System 1:										
Zone 1:										
1	Basement	15	18	21	19	16	20	*21	18	1-4
2	Living	63	*71	63	65	56	62	56	65	1-6
3	Foyer	25	38	43	34	23	35	*43	38	1-4
4	Dining	29	42	47	36	22	38	*47	42	1-5
5	Study	18	32	43	37	25	39	*43	32	1-4
6	Powder	*0	0	0	0	0	0	0	0	-
7	Family	79	80	73	84	84	*87	73	80	1-6
8	Kitchen	91	121	143	131	105	136	*143	121	1-8
9	Laundry	35	38	40	39	36	*40	40	38	1-4
10	Mudroom	*31	27	23	27	31	30	25	29	1-4
Zone 2:										
11	Bedroom4	39	51	57	49	36	50	*57	51	1-5
12	Hall	24	29	32	28	22	29	*32	29	1-4
13	Bed2	38	49	55	47	34	49	*55	49	1-5
14	Bath2	8	10	11	10	8	10	*11	10	1-4
15	Bath3	*17	15	12	15	17	15	11	14	1-4
16	Bed3	36	49	57	51	40	53	*57	49	1-5
17	WIC3	6	6	6	6	6	*6	6	6	1-4
18	Sitting	15	18	20	18	15	19	*20	18	1-4
19	MaBed	51	65	72	67	55	69	*73	65	1-6
20	MaBath1	25	35	40	35	27	37	*40	35	1-4
21	MaBath2	*14	11	8	11	14	13	9	12	1-4
22	WIC2	18	18	18	18	18	*19	18	18	1-4
23	WIC1	*24	21	17	21	24	23	19	22	1-4

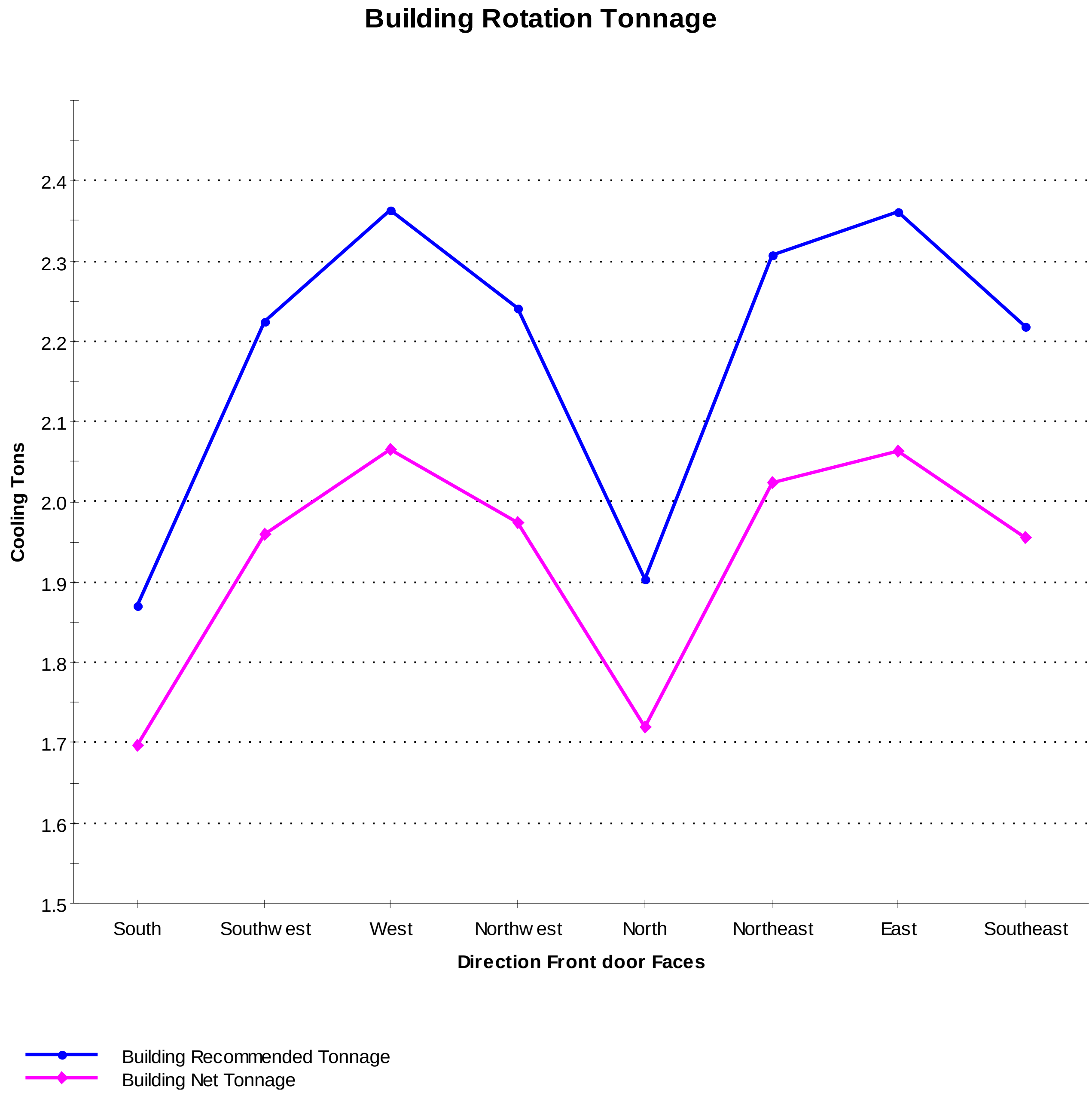
* Indicates highest CFM of all rotations.

Whole Building

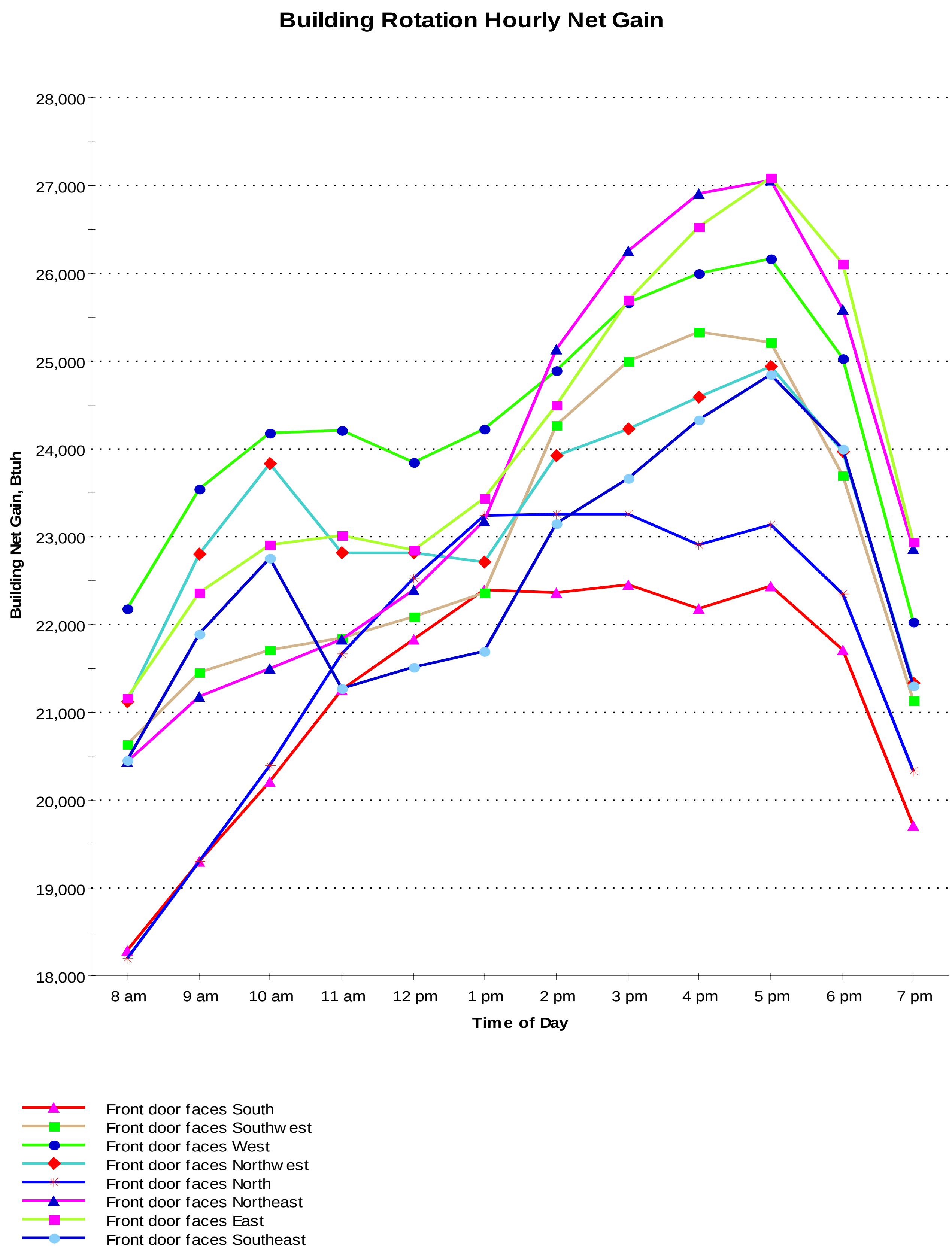
Rotation Degrees	Front door Faces	Supply CFM	Sensible Gain	Latent Gain	Net Tons	Recommended Tons
0°	South	699	16,843	*3,507	1.70	1.87
45°	Southwest	844	20,021	3,507	1.96	2.22
90°	West	*901	*21,279	3,507	*2.07	*2.36
135°	Northwest	851	20,177	3,507	1.97	2.24
180°	North	713	17,139	3,507	1.72	1.90
225°	Northeast	878	20,769	3,507	2.02	2.31
270°	East	900	21,250	3,507	2.06	2.36
315°	Southeast	842	19,971	3,507	1.96	2.22

* Indicates highest value of all rotations.

Building Rotation Report (cont'd)



Building Rotation Report (cont'd)



Building Rotation Duct Sizes

Room or Duct Name	Direction Front door Faces																Max Duct Size
	S		SW		W		NW		N		NE		E		SE		
	Htg Flow	Clg Flow	Htg Flow	Clg Flow	Htg Flow	Clg Flow	Htg Flow	Clg Flow	Htg Flow	Clg Flow	Htg Flow	Clg Flow	Htg Flow	Clg Flow	Htg Flow	Clg Flow	
System 1																	
Supply Runouts																	
Zone 1																	
1-Basement	182	21	182	22	182	23	182	23	182	23	182	23	182	23	182	22	1-4
2-Living	31	90	31	84	31	70	31	77	31	79	31	71	31	63	31	78	1-6
3-Foyer	26	35	26	45	26	47	26	40	26	32	26	40	26	47	26	45	1-5
4-Dining	21	41	21	49	21	53	21	43	21	30	21	43	21	53	21	50	1-5
5-Study	23	26	23	38	23	47	23	44	23	35	23	44	23	48	23	38	1-5
6-Powder	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0-0
7-Family	34	113	34	95	34	81	34	98	34	117	34	99	34	81	34	95	1-7
8-Kitchen	36	131	36	143	36	158	36	154	36	148	36	155	36	159	36	143	1-8
9-Laundry	11	49	11	45	11	45	11	46	11	51	11	46	11	45	11	45	1-5
10-Mudroom	23	44	23	32	23	25	23	32	23	43	23	34	23	28	23	35	1-5
Zone 2																	
11-Bedroom4	25	56	25	60	25	63	25	57	25	50	25	57	25	63	25	60	1-5
12-Hall	18	34	18	35	18	36	18	33	18	31	18	33	18	36	18	35	1-4
13-Bed2	19	54	19	58	19	61	19	55	19	48	19	56	19	61	19	58	1-5
14-Bath2	9	12	9	12	9	12	9	12	9	12	9	12	9	12	9	12	1-4
15-Bath3	10	24	10	18	10	14	10	18	10	23	10	17	10	12	10	17	1-4
16-Bed3	25	51	25	58	25	63	25	60	25	56	25	60	25	63	25	58	1-5
17-WIC3	5	8	5	7	5	6	5	7	5	8	5	7	5	6	5	7	1-4
18-Sitting	13	21	13	21	13	22	13	21	13	21	13	22	13	22	13	22	1-4
19-MaBed	25	74	25	76	25	80	25	78	25	77	25	78	25	81	25	77	1-6
20-MaBath1	23	35	23	41	23	45	23	42	23	38	23	42	23	45	23	41	1-5
21-MaBath2	7	19	7	13	7	9	7	13	7	19	7	15	7	10	7	15	1-4
22-WIC2	15	26	15	21	15	20	15	21	15	25	15	21	15	20	15	22	1-4
23-WIC1	18	34	18	25	18	19	18	25	18	33	18	26	18	21	18	26	1-4
Other Ducts																	
Supply Main Trunk	600	1,000	600	1,000	600	1,000	600	1,000	600	1,000	600	1,000	600	1,000	600	1,000	14x14
Bldg. High Dir.: West																	
Sensible Gain: 21,279																	
Latent Gain: 3,507																	