8. GREENCRAFT BUILDERS LEWISVILLE HOUSE, LEWISVILLE, TX

8.1 Executive Summary

Gate 2 - Prototype: Lewisville House, Greencraft Builders, Dallas, TX

Overview

Greencraft Builders LLC is a custom home builder that has been constructing Building America prototypes for three years. The partners involved in the effort are the builder (Greencraft), the architect (William Peck and Associates) and Building Science Corporation. The Lewisville house was constructed to the highest standards in efficiency, durability and sustainability. It is a quality demonstration of the type of construction that a Building America Prototype should endeavor to be.

Key Results

The Lewisville house was constructed to Building America standards by Greencraft Builders LLC. It will serve as a demonstration house for guests to tour and then it will be occupied by a family. This house incorporates many advanced technologies advocated by Building America and Building Science Corporation.

Gate Status

Table 8.1-1: Stage Gate Status Summary

"Must Meet" Gate Criteria	Status	Summary
Source Energy Savings	Pass	The Lewisville house meets the 50% minimum source energy savings threshold as defined by the 2009 Building America Benchmark.
Prescriptive-Based Code Approval	Pass	The Lewisville House meets the local building code – 2006 IBC.
Quality Control Requirements	Pass	Greencraft maintains quality control through constant communication and onsite reviews by the builder and the architect. Detailed drawing sets from the architect and documented specifications from BSC augments the quality service that Greencraft provides.

"Should Meet" Gate Criteria	Status	Summary
Neutral Cost Target	Pass	This home exceeds the neutral cost target when the cost of improvements is financed as part of a 30 year mortgage. This annual amortized cost is less than the energy savings of the homes compared to the BA Benchmark.
Quality Control Integration	Pass	Quality control is specified by documents between Greencraft and Building Science Corporation.
Gaps Analysis	Pass	BSC and Greencraft attempted to integrate XPS insulation on the slab edge but were unable to. Greencraft will try to include this and other characteristics in future homes.

Conclusions

The Lewisville house is the first Net Zero house constructed by Greencraft Builders LLC. This house began construction in June 2009 and expected to be finished by November 2009. It will be commissioned by Building Science Corporation once construction is

finished. This house exceeds the 50% energy savings threshold as defined by the Building America Benchmark. The Lewisville house is rated at a HERS 30 with 9.0 kW photovoltaics and HERS 39 without renewables. This house is expected to save $3152 annually due to the advanced technologies implemented in the construction of the home. Greencraft is a stalwart Building America partner and will continue to work closely with Building Science Corporation for the foreseeable future.

8.2 Introduction

8.2.1. Project Overview

Building Science Corporation has been collaborating with Greencraft Builders since 2005 and has forged a valuable working relationship. Greencraft has been successfully constructing highly efficient homes for years. They have been working with a local architect, William Peck and Associates, who specializes in energy efficient construction. Greencraft is based out of the Dallas Fort Worth area and specializes in mid to high market custom houses.

The Lewisville house is one of two 2009 prototypes, but is Greencraft's first Net-Zero house. It is currently under construction and is expected to be finished and ready to be tested in the middle of November 2009.

Greencraft utilized reclaimed material in the construction of the Lewisville house.

This is the largest and most expensive home that Greencraft has constructed as a part of the Building America program. It is a two-story single detached residence e with a total of 4886 sf. Construction began May 2008 and was finished March 2009. Please refer to the Appendix for the detailed floor plans. Below is a photo of the finished residence.

Figure 8.2-1: Architect draft of front elevation

The house is on an uninsulated slab on grade post tensioned foundation due to expansive soils on site. The walls are 2x6 advanced framed with low density open celled spray foam in the cavity with 1" foil faced polyisocyanurate as insulating sheathing. The roof is an unvented cathedralized attic with R-20 low density spray foam in the roof rafter cavities. Supplemental dehumidification is installed to provide dehumidification separate from heating and cooling to maintain occupant comfort year round. Mechanical ventilation provides outside air to the home and is controlled by a fan cycler.

8.2.2. Project Information Summary Sheet

PROJECT SUMMARY	
Company	GreenCraft Builders L.L.C.
Company Profile	GreenCraft Builders L.L.C. is the culmination of more than 30 years of experience building and remodeling homes in the Dallas/Fort Worth metroplex. Since 2004, Chris Miles, principal of GreenCraft, has been recognized as a leader in the North Texas green building industry, first as a producer and project manager, and now as a builder with his company, GreenCraft Builders L.L.C.
Contact Information	Chris Miles GreenCraft Builders L.L.C. 105 West Main Street Lewisville, TX 75057 (214) 718-8424 http://www.greencraftbuilders.com/
Company Type	Custom Home Builder
Address	937 Timber Creek Drive
City, State	Lewisville, TX 75067
Climate Region	Mixed-Humid, IECC Zone 3A

SPECIFICATIONS	
Number of Houses	1
Municipal Address	937 Timber Creek Drive, Lewisville, TX 75067
House Style	Single Family Detached with attached garage
Number of Stories	2
Number of Bedrooms	4
Plan Number(s)	Timber Creek Zero Energy House
Floor Area	2409 ft^2
Estimated Energy Reduction	53% over BA Benchmark, before PV, 92% with 9.0 kW PV
Estimated Energy Savings	$2,015 annual savings before PV, $3674 with PV
Estimated Cost	$395,000 or $163/$ft^2$
Construction Start	June 2009
Construction Finish	November 2009 - Expected

8.2.3. Targets and Goals

The Lewisville House has been designed as a Building America prototype house to meet a 50% reduction in whole house energy use when compared to the Building America Benchmark. The goal of the Lewisville house is to attain Net-Zero energy status. That is, to generate enough source energy as is used in the house over the course of a year. There are natural gas appliances, including two water heaters, cooking range and clothes dryer. The source energy used by the natural gas is also included in the determination of Net Zero status. A 9.0 kW photovoltaic system will be installed. This PV system will have multiple inverters which will allow for expansion if Net Zero status cannot be reached after a year of operation. Greencraft believes that 9.0 kW of PV will be enough to achieve

Net Zero status, despite the Building America analysis that shows 9.0 kW may not be enough.

The Lewisville Eco House is a demonstration project for the US Department of Energy's "Building America" program to encourage homeowners and builders to live and build in a more fiscally and environmentally sensible manner.

A primary goal set for the project by Greencraft was to construct a prototype house that demonstrates key energy efficiency, durability, and sustainability features. Achieved certifications include:

- Building America Builders Challenge Program
- USGBC LEED®-H Gold
- Green Built™ North Texas
- NAHB National Green Building Program™ - Gold
- EPA Energy Star® for Homes

Specific goals of the 2009 Lewisville house are:

- To promote spray foam unvented roofs as an effective way to locate the HVAC system within the building enclosure, and to reduce building infiltration.
- To utilize full Optimum Value Engineering (OVE) Advanced Framing in the enclosure construction. This consists of 2x6 studs at 24”o.c. with two stud energy corners, single top plate and reduction in window framing. Also included is stacked framing with both the floor joists and roof trusses spaced at 24”o.c.
- To encourage the utilization of a single heat pump system that will provide supplemental dehumidification along with heating and cooling. .

8.3 Whole-House Performance and Systems Engineering

8.3.1. Energy Analysis Summary

Table 8.3-1: Estimated Whole House Energy Use for the Lewisville House

ESTIMATED WHOLE HOUSE ENERGY USE		
Source (10^6 BTU/yr)	**Site (10^6 BTU/yr)**	**Area + Bsmt (sq ft)**
166	62	2409 + 0
	% Electric	**No. of Bedrooms**
	70%	3

With the enclosure and mechanical characteristics presented in Table 8.3-5 and Table 8.3-6, this plan achieves a performance level of 53% reduction relative to the Building America Benchmark without renewable energy installations.

The table below shows the net whole house energy use with the 9.0 kW photovoltaic array included in the simulation. This shows that the renewable installation is expected to generate around 140 million BTUs of source energy annually. As the table shows, according to the energy analysis this may not be enough to achieve full Net Zero status. However, Greencraft believes that 9.0 kW may be enough based off of utility bill data from the 2007 Bannister house. The 2007 Bannister house has a similar floor plan and also has an energy conscious family occupying it.

Table 8.3-2: Estimated House Energy Net Generation for the Lewisville House

ESTIMATED HOUSE ENERGY NET GENERATION		
Source (10^6 BTU/yr)	**Site (10^6 BTU/yr)**	**Area + Bsmt (sq ft)**
27	21	2409 + 0
	% Electric	**No. of Bedrooms**
	9%	3

8.3.1.1. Parametric Energy Simulations

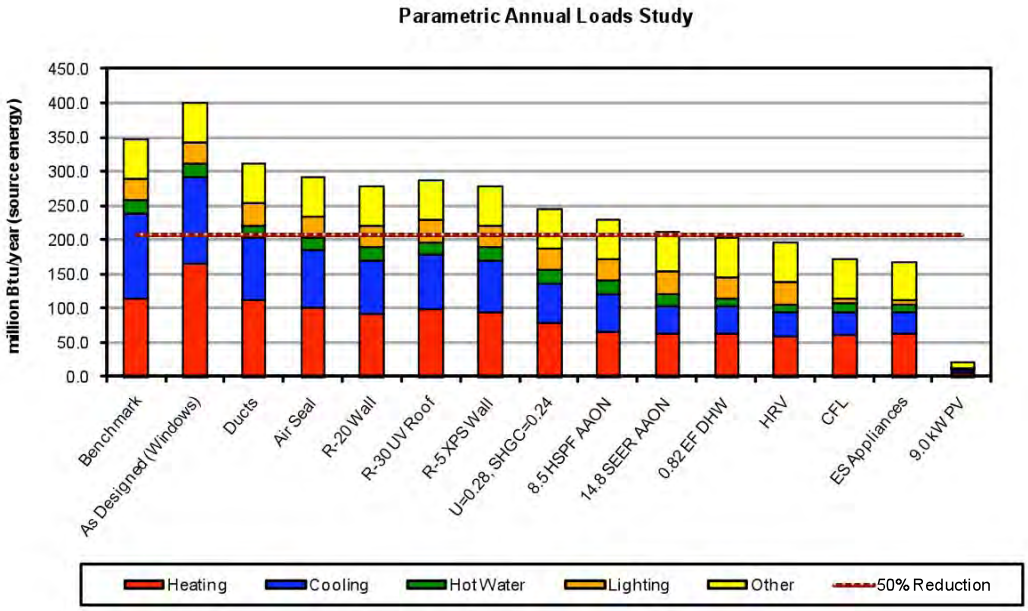


Figure 8.3-1: Parametric energy simulations for the Lewisville House

The Lewisville house exceeds the Building America Prototype energy threshold of 50% without PV contributions.

The following incremental improvements had the largest impact on the efficiency of the prototype vs. the benchmark (in order, not including renewable installations):

5. Ground Source Heat Pump
6. Ducts inside conditioned space and duct leakage to outside reduced to 1% of flow
7. Air Seal to 0.9 in^2 per 100 ft^2 of enclosure area
8. Vinyl framed double paned windows with LoE^3 spectrally selective coating

8.3.1.2. End-Use Site and Source Energy Summaries

Table 8.3-3: Summary of End-Use Site-Energy

	Annual Site Energy			
	Benchmark		Prototype	
End-Use	kWh	therms	kWh	therms
Space Heating	9568	0	5410	0
Space Cooling	10859		2764	
DHW	0	175	0	85
Lighting*	2734		644	
Appliances + Plug	4729	101	3842	101
OA Ventilation**	67		69	
Total Usage	27957	276	12729	186
Site Generation			12170	
Net Energy Use	27957	276	12729	186

Table 8.3-4: Summary of End-Use Source-Energy and Savings

			Source Energy Savings	
	Estimated Annual Source Energy		% of End-Use	% of Total
	Benchmark	Prototype	Prototype	Prototype
End-Use	10^6 BTU/yr	10^6 BTU/yr	savings	savings
Space Heating	109.9	62.1	**43%**	**14%**
Space Cooling	124.7	31.7	**75%**	**26%**
DHW	19.1	9.3	**51%**	**3%**
Lighting*	31.4	7.4	**76%**	**7%**
Appliances + Plug	65.3	55.1	**16%**	**3%**
OA Ventilation**	0.8	0.8	**-3%**	**0%**
Total Usage	351	166	**53%**	**53%**
Site Generation	0	-140		**40%**
Net Energy Use	351	166	**53%**	**92%**

8.3.2. Discussion

8.3.2.1. Enclosure Design

Table 8.3-5 (below) summarizes the building enclosure assemblies used for this project.

Table 8.3-5: Enclosure Specifications

ENCLOSURE	SPECIFICATIONS
Ceiling	
Description -	Standing Seam metal roof - Unvented Cathedralized Attic
Insulation -	8.6" R-30 low density open cell spray foam in roof rafter cavity
Walls	
Description -	Advance Framed with ½"OSB at the corners for structural 2x6 wood studs 24" o.c., two stud corners single top plate Stacked framing with floor joists and roof trusses at 24"o.c.
Insulation -	R-20 low density open cell spray foam + 1" R-5.4 foil faced polyisocyanurate insulating sheathing
Foundation	
Description -	Slab on grade – Post Tensioned with Termimesh® barrier system Slab is 51% fly ash
Insulation -	Non insulated
Windows	
Description -	Double Pane Fiberglass Framed
Manufacturer -	Pella® Impervia®
U-value -	U = 0.28 Btu/hr-ft^2°F
SHGC -	SHGC = 0.22
Infiltration	
Specification -	2.5 in^2 leakage area per 100 ft^2 enclosure, 3149 CFM 50, 2.5 ACH 50
Performance test -	Not available until mid November, 2009

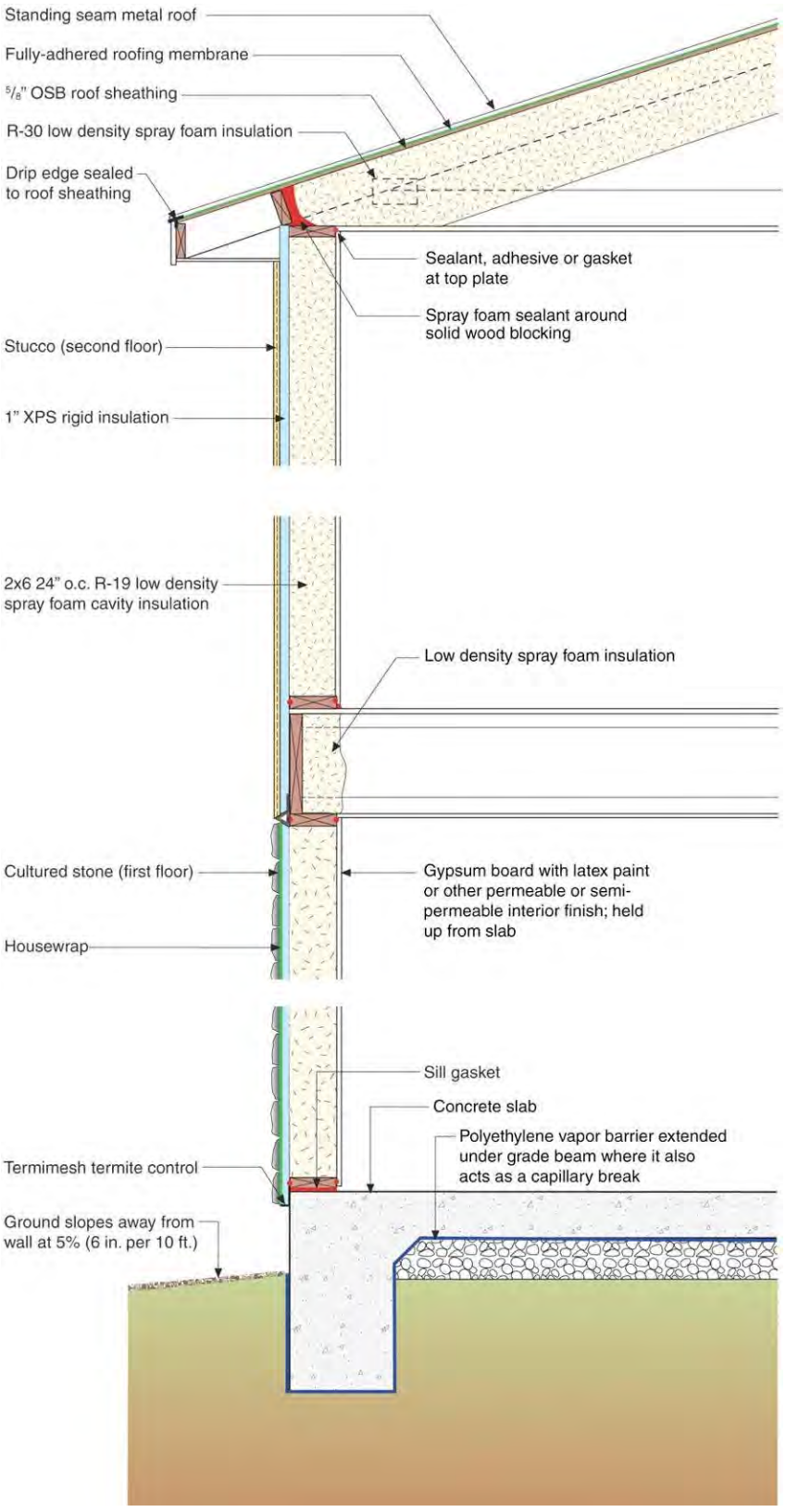


Figure 8.3-2: Enclosure Building Section

Greencraft has been constructing unvented cathedralized attics for years and prefers them versus a traditional vented attic. An unvented cathedralized attic allows the HVAC system to remain where it is initially designed to be, and to become a part of conditioned space. This does require rafter construction versus roof trusses but Greencraft has integrated this change into their framing without any trouble. Their framers are familiar with unvented cathedralized attic construction as well as OVE (Optimized Value Engineering) in general.

Figure 8.3-3: Unvented cathedralized attic with foam installed at the roof and knee walls

Figure 8.3-4: Open cell low density spray foam unvented cathedralized attic with the HVAC system

Greencraft installed a standing seam roof over a fully adhered membrane installed on the roof sheathing. The metal is 24 gauge galvanized with an acrylic coating. It is rolled, cut and crimped onsite for proper installation. The fully adhered membrane provides a durable water resistive roof barrier. Any fastener penetrations through the roofing membrane are automatically sealed due to the elasticity of the membrane.

Figure 8.3-5: Fully adhered roofing membrane installed before standing seam roof

Figure 8.3-6: Standing seam metal roof

The entire structure is Advanced Framed. The roof rafters are spaced 24" on center and all framing is stack framed. The walls are 2x6 spaced 24" and are stacked below the roof rafters and above the rim joist framing to ensure proper stacked framing. The wall top plate can now be reduced from two to one. The corners are constructed of 2 stud rather

than 3 or 4 to maximize the cavity space for insulation. The top plates of the walls are all single stud and 24" splices are used at the joints. The windows are framed with one header set outboard of the structure. This allows for insulation at the headers. Reduced framing is utilized in the windows, resulting in a more efficient stud layout.

Figure 8.3-7: Advanced framed walls – 2x6 studs at 24" o.c.

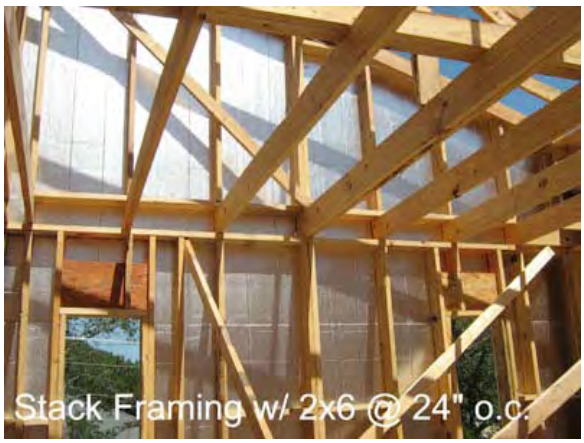


Figure 8.3-8: Stacked framing

Another element of advanced framing is the omission of all cripple studs adjacent to window jack studs. These are not necessary from a structural perspective. Greencraft does install one cripple as a minimum and uses that cripple to measure up the sill stud first.

Figure 8.3-9: Insulted window headers reduces thermal bridging losses over windows

Figure 8.3-10: Two stud exterior corners with OSB drywall nailing bases maximize insulation at the corners

The windows are double paned fiberglass framed with state of the art LoE^3 coating to achieve one of the best performing windows in the residential construction industry. Fiberglass frames are much stronger and dimensionally stable than vinyl. This results in high quality operation and much improved durability.

The exterior walls have 1"foil faced polyisocyanurate insulating sheathing. This reduces the energy losses from thermal bridging through the exterior studs. At the corners ½" OSB is installed for structural support. The OSB is installed 4' from the corner and then the wall resumes the 1" polyisocyanurate in the field. ½" polyisocyanurate is installed over

the OSB to add insulation and to provide a smooth surface for continuing the construction of the exterior wall. DuPont™ Tyvek® ThermaWrap™ is installed as a housewrap on the entire enclosure. It serves as a water resistive membrane to drain water out from the wall assembly.

The exterior wall is clad half in brick (some of which is reclaimed from the building preciously on site) and half in stone. The transition between the two cladding systems is critical to be installed correctly in order to effectively control rainwater entry and air infiltration. The housewrap continually envelopes behind both wall claddings so there is no leakage at the joint between the stone and the fiber cement.

Figure 8.3-11: Fiberglass LoE^3 windows

Figure 8.3-12: Window with brick cladding installed

The foundation is post-tensioned slab on grade, which is typical for this area. The concrete has 51% fly ash content. Insulation was not able to be installed due to the post tensioning, however BSC is focusing on integrating XPS insulation in future prototype slabs. Please refer to the appendix for potential slab design details that will be considered in future Greencraft Prototype homes. Termimesh®, a mesh based termite barrier system, is installed at slab penetrations and at the slab edge behind the brick cladding.

Figure 8.3-13: Termimesh® termite barrier installed at slab penetrations before slab casting

Figure 8.3-14: Slab penetrations after slab casting

Infiltration is controlled by the spray foam in the walls, rim joist and roof. All penetrations are foam sealed and all windows have a bead of foam sealing the rough openings. This is

expected to result in an exceedingly air tight enclosure. Greencraft Builders has a successful track record of controlling infiltration through spray foam air sealing.

Figure 8.3-15: Low density open cell spray foam being installed in the unvented cathedralized attic and exterior walls

Figure 8.3-16: Low density open cell spray foam installed and shaved prior to drywall installation

8.3.2.2. Mechanical System Design

Table 8.3-6 (below) summarizes the mechanical systems used by this project.

Table 8.3-6: Mechanical system specifications

MECHANICAL SYSTEMS	SPECIFICATIONS
Heating (outdoor unit)	
Description -	8.5 HSPF Air Source Heat Pump
Manufacturer & Model -	AAON® CB Series
Cooling (outdoor unit)	
Description -	14.8 SEER Air Source Heat Pump
Manufacturer & Model -	AAON® CB Series
Air Handler (indoor unit)	
Description -	Variable Speed Air Handler + High Efficiency Air Filter
Manufacturer & Model -	AAON® F1 Series
Domestic Hot Water	
Description -	Instantaneous Tankless Hot Water + Separate tank for GSHP DHW
Manufacturer & Model -	Noritz® (0.94 EF)
Distribution	
Description -	Duct board and R-6 flex duct run outs in conditioned attic
Leakage -	5% leakage to outside
Ventilation	

MECHANICAL SYSTEMS	SPECIFICATIONS
Description -	Central Fan Integrated Supply (CFIS) ventilation system 50 CFM 33% Duty Cycle: 10 minutes on; 20 minutes off Energy Recovery Ventilator Inline exhaust fan for all bathrooms
Manufacturer & Model -	Aprilaire® Model 8126 Ventilation Control System (VCS) Fantech® FR 150 inline exhaust fan for all bathrooms
Dehumidification	
Description -	Modulating Hot Gas Reheat Coil on heat pump
Manufacturer & Model -	AAON® CB Heat Pump + AAON® F1 Air Handler
Return Pathways	
Description -	R-6 flex ducts to bedrooms and laundry room
PV System	
Description -	9 kW array
Manufacturer & Model -	Supplier: Meridian Solar | Manufacturer: Sharp® Corporation

Heating and cooling is provided by an AAON® air source heat pump. The overall system is rated at 8.5 heating and 14.8 SEER cooling. This system includes a reheat coil that allows for dehumidification separate from heating and cooling. This is achieved through a modulating hot gas reheat coil that heats the incoming cool and dehumidified air up to the room dry bulb temperature.

Figure 8.3-17: AAON® CB heat pump

Figure 8.3-18: AAON® F1 air handler with reheat coil

The Lewisville house is in a Mixed-Humid climate, thus BSC recommends supplemental dehumidification to control humidity levels when air conditioning is not appropriate. Supplemental dehumidification is one of the key improvements to the prototype, and is necessary because of the very efficient enclosure. The sensible load has been reduced such that the ratio of sensible to latent load is very different than in a standard home. Supplemental dehumidification will provide the occupant with the ability to control indoor humidity levels all year round. This will have a beneficial impact on the comfort and durability of the structure by preventing high humidity levels and potential mold risks.

The outside air ventilation design is Central Fan Integrated Supply (CFIS) ventilation that is controlled by the Aprilaire® Model 8126 VCS fan cycler that is installed at the supply plenum. A 6" insulated flex duct draws outside air from an exterior wall location and dumps it into the ERV. There is a mechanical damper on this duct that is controlled by the fan cycler to prevent over ventilation during periods of high operation. The fan cycler also turns on the air handler alone during periods of low operation to bring in outside air and mix the interior air. This ensures proper ventilation and maintains a homogenous indoor environment. The bathroom exhausts are all connected in parallel to a single exhaust duct that is powered via the Fantech FR 150 inline fan.

The figure below shows the HVAC design that integrates the air handler with the whole house dehumidification system.

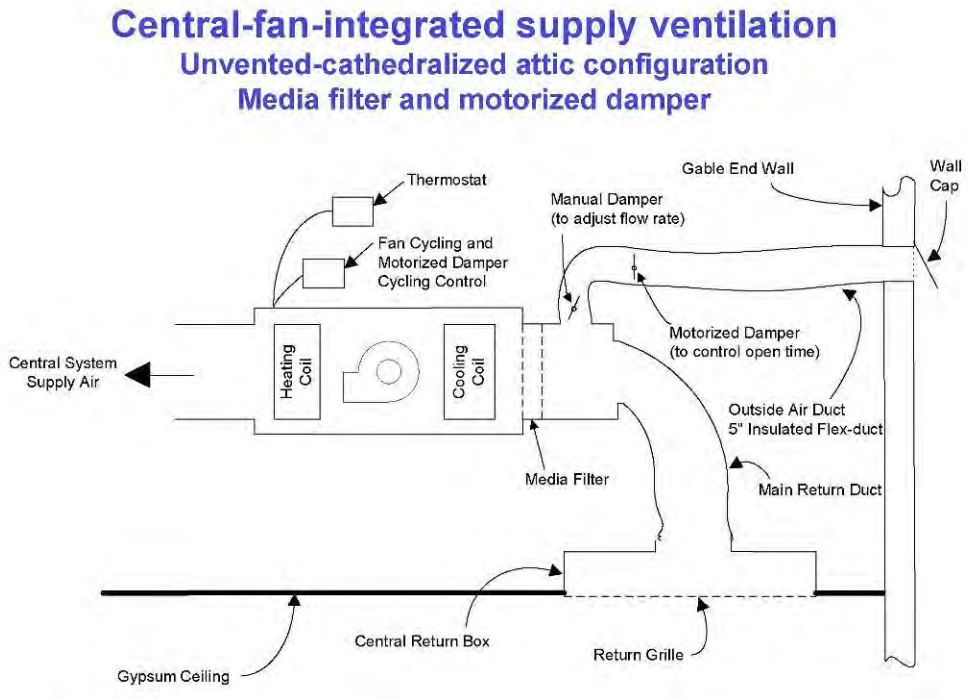


Figure 8.3-19: Central Fan Integrated Supply Ventilation Schematic

There will be a highly efficient wide media air filter installed to properly filter the HVAC air.

8.3.2.3. Lighting and Miscellaneous Electrical Loads

The Lewisville house has 100% fluorescent lighting, with around 10% pin based in the kitchen area and 90% compact fluorescent everywhere else. There are four LED lights installed as a demonstration of the technology. The refrigerator, clothes washer and dishwasher are all Energy Star rated.

8.3.2.4. Site-generated Renewable Energy

Meridian Solar installed a 9.0 kW PV system from Sharp® Corporation. It is expected to produce 12170 kWh annually, which converts to 130 million Btus source energy produced.

8.4 Construction Support

8.4.1. Construction Overview

Construction began in June 2009 and is expected to be finished by mid November 2009. Greencraft did not come across any major enclosure or HVAC related problems during construction. The AAON heat pump unit did experience shipping delays. The first unit that was sent did not have the digital scroll compressor, so AAON had to send another one.

8.4.2. Educational Events and Training

This house, like all Greencraft Prototype homes, will be a demonstration house for some time before it is permanently occupied. It is expected to be toured extensively by a range of interested parties including potential homeowners and local builders and energy professionals. This will be starting in mid November 2009 after the home has finished construction and has been commissioned by Building Science Corporation.

8.4.3. Systems Testing

Testing and commissioning of the building enclosure and mechanical systems will be performed by BSC to ensure the house will operate as designed. The following tests will be performed:

- Air leakage
- Duct leakage
- Local air flows
- System external static pressure
- Outside air duct air flow
- Proper configuration and operation of the AAON heat pump

8.4.4. Monitoring

It is likely that Building Science Corporation will install some monitoring equipment to track the interior conditions and potentially the heat pump/dehumidification operating. Details are not available at this time however.

8.5 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.

8.5.1. 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 project is estimated to achieve a source energy savings of 53% prior to the additional of renewable energy strategies. The energy savings is increased to 92% with the addition of a 9.0 kW roof mounted photovoltaic system. The percentage savings were calculated with FSEC's Energy Gauge USA v. 2.8.02 and the 2009 Building America Benchmark defined the comparison home. This is achieved through the design and construction of a high quality enclosure and the installation of highly efficient mechanical systems.

8.5.2. Prescriptive-based Code Approval

Requirement:	*Must meet prescriptive or performance safety, health and building code requirements for new homes.*
Conclusion:	***Pass***

The city of Lewisville currently adopts the 2006 International Building Code. The Lewisville house meets this and all local building codes and has been designed and constructed to maintain a healthy living environment. Full advanced framing has been accepted by the local code officials for the past four years. Greencraft has been changing the way the code officials understand advanced framing and has served as a local example of exemplary construction.

8.5.3. 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***

Greencraft Builders LLC provides quality assurance and quality control through construction site management. A site/construction manager typically reviews the progress of construction on a regular basis. BSC worked with Greencraft to ensure proper quality control through implementation of quality construction practices into their building environment. Greencraft maintains excellent quality control from initial design to the finished building. The architect creates very detailed drawing sets with details that specifically outline a certain characteristic. The owner of Greencraft as well as a superintendent both tour the homes regularly and will demand any deviations from the design to be remedies immediately.

Greencraft maintains constant communication within the company and between contractors or the architect. Contractors are made aware of their responsibility and their work is checked often.

8.5.4. Neutral Cost Target

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

Conclusion:	***Pass***

The Lewisville house achieves a positive cost target with respect to annual mortgage payments not including the 9.0 kW photovoltaic system. This means that the annual energy savings is higher than the additional annual amortized mortgage cost without renewables.

Incremental cost data was generated directly from Greencraft Builders LLC. The Neutral Cost Analysis Worksheet below shows that the Lewisville house does qualify without renewables. The house is expected to save $2015 a year compared to the additional amortized mortgage payments. The mortgage is assumed to be a 30-year plan at a rate of 7%. This is an important selling point that Greencraft uses with prospective home buyers.

Table 8.5-1: Lewisville House Neutral Cost Analysis

	Annual kWh Use (Site)		Annual Therm Use (Site)		
	Benchmark	Prototype House	Benchmark	Prototype House	Annual Utility Bill Reduction vs Benchmark
End Use	**(kWh/yr)**	**(kWh/yr)**	**(therms/yr)**	**(therms/yr)**	**($/yr)**
Space Heating	9568	5410	0	0	$541
Space Cooling	10859	2764	0	0	$1,052
DHW	0	0	175	85	$113
Lighting	2734	644	0	0	$272
Appliances and MELs	4729	3842	101	101	$115
Ventilation	67	69	0	0	($0)
Total Usage	**27957**	**12729**	**276**	**186**	**$2,092**
Site Generation	0	12170	0	0	$1,582
Net Energy Use	**27957**	**559**	**276**	**186**	**$3,674**
Added Annual Mortgage Cost w/o Site Gen.					**$2,015**
Net Cash Flow to Consumer w/o Site Gen.					**$77**
Added Annual Mortgage Cost with Site Gen.					**$4,650**
Net Cash Flow to Consumer with Site Gen.					**($976)**

The annual savings from energy improvements, compared to the cost of the energy efficiency upgrades to the home compared to the incremental annual cost of energy improvements, when financed as part of a 30-year mortgage, results in a positive annual cash flow. However, the addition of the 9kW PV array does lower the net cash flow enough to negative cash flow.

The estimated annual utility savings were based on local utility rates provided by Greencraft Builders LLC (Natural Gas $1.25/therm; Electricity $0.13/kWh).

8.5.5. 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***

Greencraft Builders LLC provides integrated quality control throughout the construction of the house to ensure that building specifications are met. This is achieved through periodic tours of the house during different levels of construction to check various building specifications. Any element of the house that is not to specifications is immediately remedied.

Details are generated in both the architectural and engineering documents to clearly outline the expected quality assurance. Please refer to the appendix for documents.

8.5.6. 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 current design for Greencraft design is effective at reducing the cooling load. However, efforts can be increased to reduce the heating load. Despite being a Mixed-Humid climate zone, Dallas has enough of a heating load to be of concern from an energy efficiency standpoint.

A gap that was noted during the construction of the Lewisville house was the lack of any slab insulation. BSC and Greencraft attempted to include exterior slab insulation but the post-tensioned slab design did not work. BSC suggested that the slab be a stem wall in order to avoid the post tensioning that was blocking the continuity of the slab insulation. This was unable to be achieved in the Lewisville house but Greencraft would like to readdress this design in future prototype homes.

8.6 Conclusions/Remarks

Greencraft Builders constructed a 50% Prototype house in 2009 that incorporates advanced building technologies that positively impact the durability and efficiency of the residence as well as ensuring higher levels of comfort and health in the living space. Greencraft Builders is dedicated to energy efficient construction and the practice of integrating quality building science in their homes.

The home as currently designed achieves a 53% source energy consumption reduction when compared to the 2009 Building America Benchmark (above the required 50% BA goal for prototype homes). A 9.0 kW photovoltaic array produces electricity and increases the total savings to 92%. The building is expected to save around $2015 a year compared to the Building America benchmark without renewables or $3674 with the 9.0 kW photovoltaic installed. The Lewisville house does qualify for the Builders Challenge with a HERS Index of 57 with no PV system or a HERS 8 with the 9.0 kW PV installation.

Significant aspects of the design include the PV spray foam unvented roof and supplemental dehumidification. The low density spray foam installed in the unvented roof, as well as in the walls will result in a very tight building enclosure. Supplemental dehumidification will ensure occupant comfort all year round and will control humidity levels separately from the HVAC system. Other important design elements include LoE3 vinyl windows, CFL lights and Energy Star® appliances.

The construction of this house has received a lot of local attention and will be used as a demonstration house when it is finished for a few months before it is permanently occupied.

Gaps and lessons learned were identified throughout the design and construction process.

BSC and Greencraft Builders LLC intend to continue working together on this and future projects. The goal is to keep pushing for greater energy savings. Greencraft remains a stellar example of a quality custom home builder.

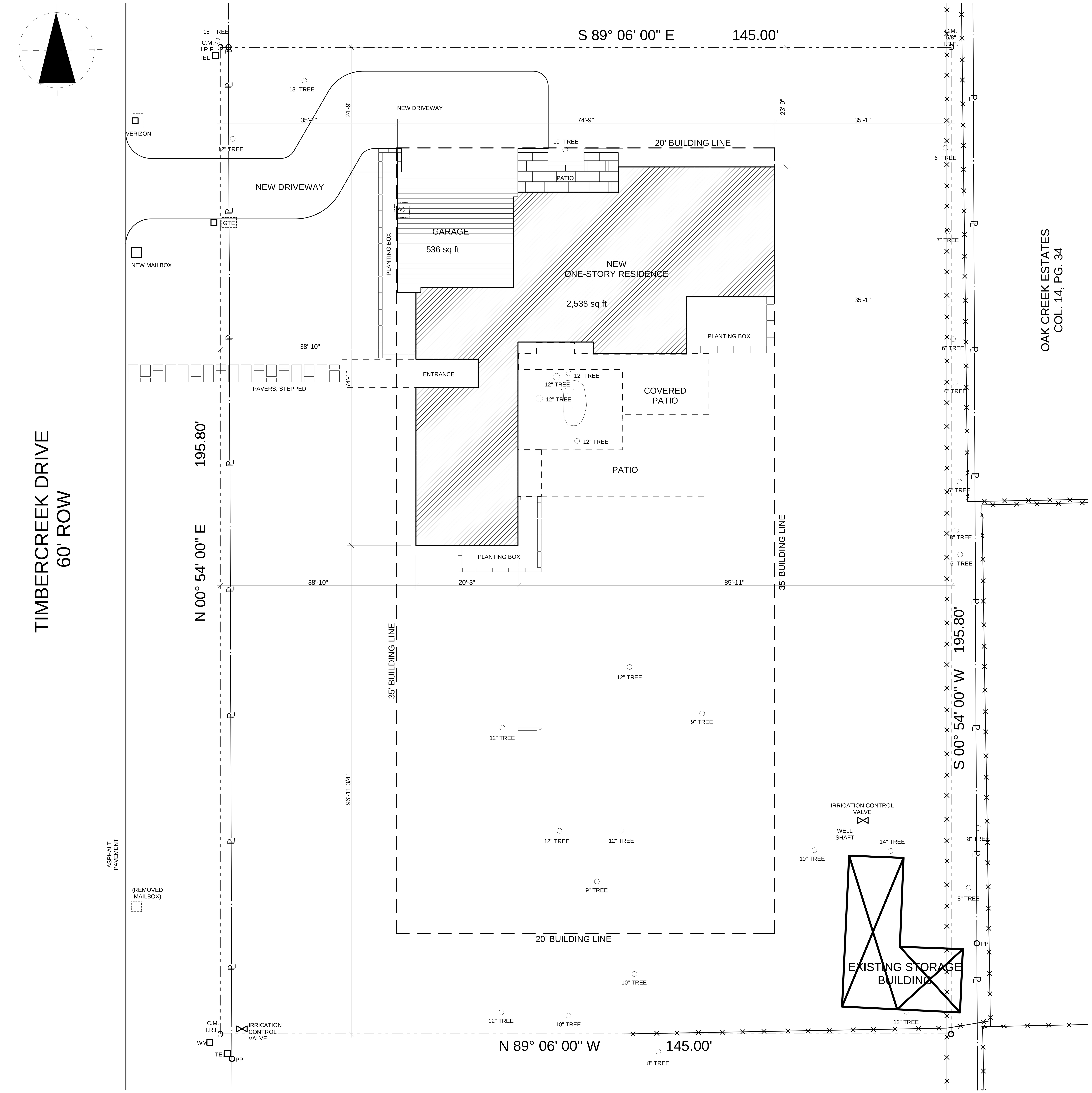
8.7 Appendices

8.7.1. Drawings and Specifications

8.7.2. Energy Modeling

8.7.3. Mechanical System Design

Appendix D.8.7.1
Drawings and Specifications



A SITE PLAN

SCALE: 1" = 10'

05-15-09

These plans are intended to provide the basic construction information necessary to substantially complete this structure. These construction documents must be verified and checked by the builder or person in authority of this project. Any discrepancy, error, and/ or omissions, if any, are to be brought to the attention of the Designer prior to any construction or purchases being made. It is recommended that the owner or builder obtain complete engineering services for: foundation, HVAC, and structural, prior to construction of any kind. NOTE: All Federal, state, and Local codes, ordinances, and restrictions take precedence over any part of these construction documents which may conflict with same, and must be strictly obeyed and followed before and during construction.

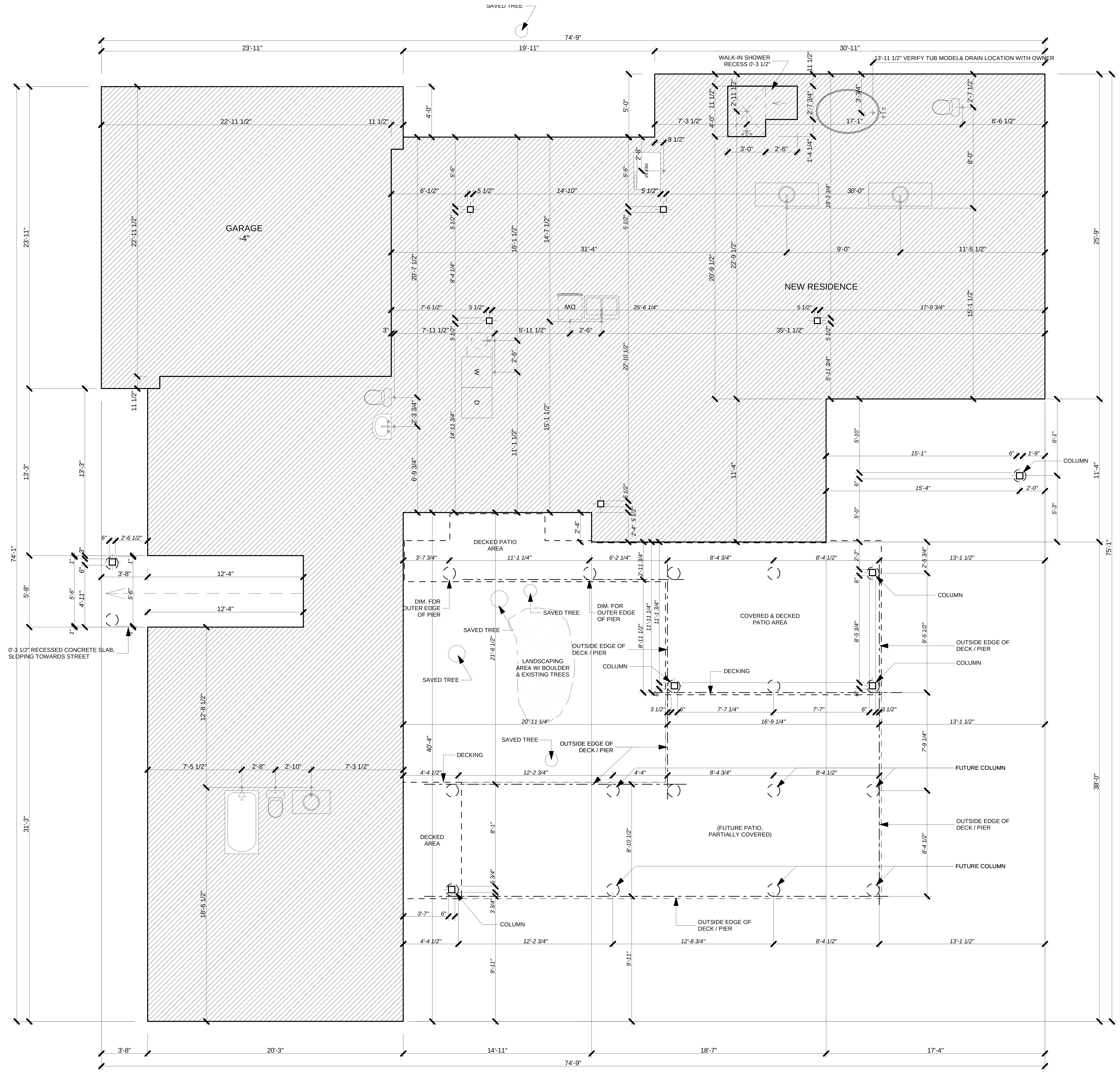
937 TIMBER CREEK DR.,
LEWISVILLE, TEXAS.

WILLIAM PECK &
ASSOCIATES INC.
ARCHITECTS
(972) 221-1424
Lewisville, Tx

SITE PLAN

REVISIONS
DATE
1 05-15-09

Date:	04-29-09
Scale:	
Drawn:	
Job:	
Sheet Number:	A-001
SHEET 1	OF 26



A FOUNDATION LAYOUT
SCALE: 1/4" = 1'-0"

REGISTERED ARCHITECT
WILLIAM C. PECK
18501
STATE OF TEXAS
05-15-09

These plans are intended to provide the basic construction information necessary to substantially complete this structure. These construction documents must be verified and checked by the builder or person in authority of this project. Any discrepancy, error, and/ or omissions, if any, are to be brought to the attention of the Designer prior to any construction or purchases being made. It is recommended that the owner or builder obtain complete engineering services for: foundation, HVAC, and structural, prior to construction of any kind.
NOTE: All Federal, state, and Local codes, ordinances, and restrictions take precedence over any part of these construction documents which may conflict with same, and must be strictly obeyed and followed before and during construction.

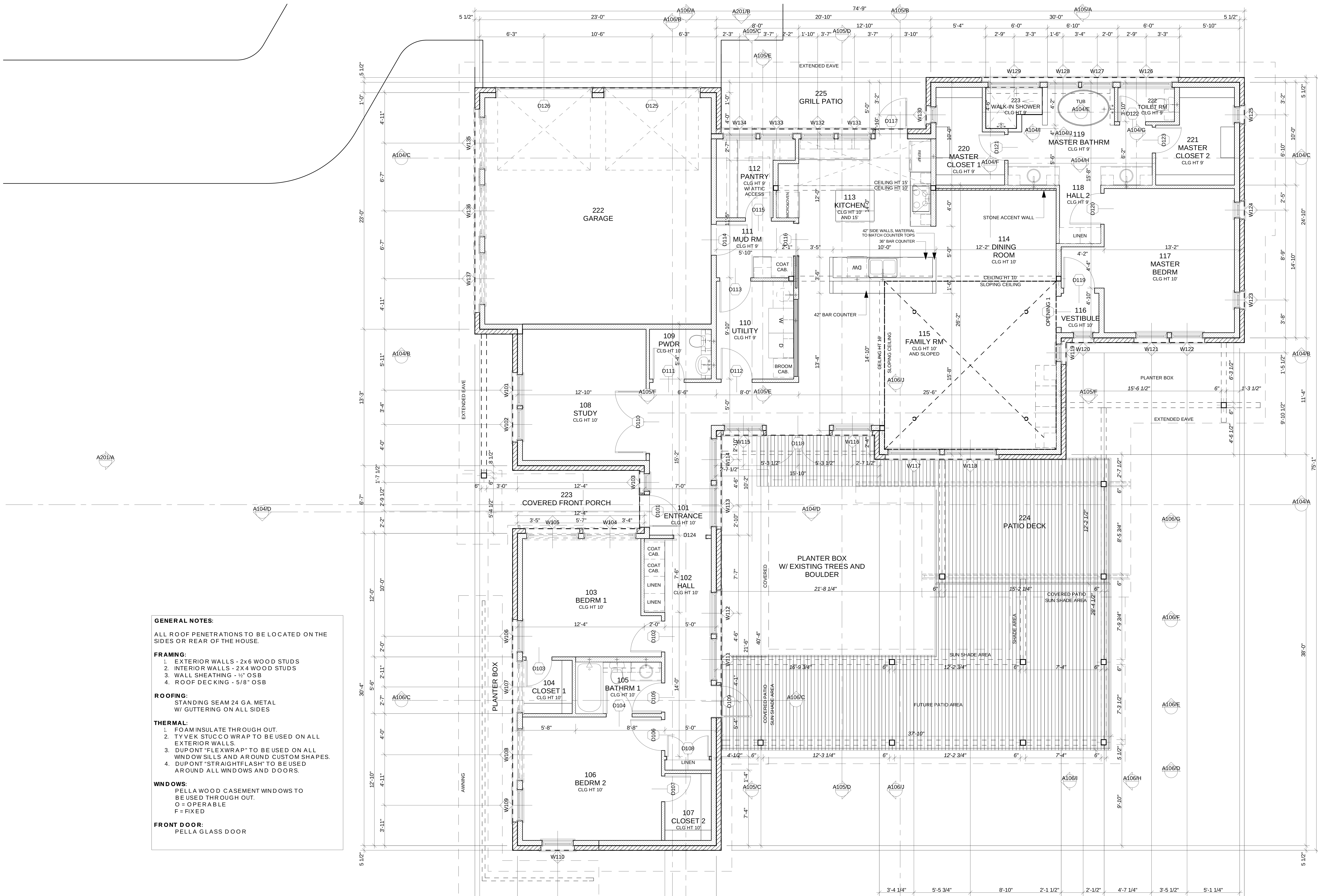
937 TIMBER CREEK DR.,
LEWISVILLE, TEXAS.

WILLIAM PECK &
ASSOCIATES INC.
ARCHITECTS
Lewisville, Tx (972) 221-1424

FOUNDATION LAYOUT

REVISIONS
DATE
1 05-15-09

Date: 04-29-09
Scale:
Drawn:
Job:
Sheet Number:
A-002
SHEET 2 OF 26



GENERAL NOTES:

ALL ROOF PENETRATIONS TO BE LOCATED ON THE SIDES OR REAR OF THE HOUSE.

FRAMING:
1. EXTERIOR WALLS - 2x6 WOOD STUDS
2. INTERIOR WALLS - 2X4 WOOD STUDS
3. WALL SHEATHING - ½" OSB
4. ROOF DECKING - 5/8" OSB

ROOFING:
STANDING SEAM 24 GA. METAL
W/ GUTTERING ON ALL SIDES

THERMAL:
1. FOAM INSULATE THROUGH OUT.
2. TYVEK STUCCO WRAP TO BE USED ON ALL EXTERIOR WALLS.
3. DUPONT "FLEXWRAP" TO BE USED ON ALL WINDOW SILLS AND AROUND CUSTOM SHAPES.
4. DUPONT "STRAIGHTFLASH" TO BE USED AROUND ALL WINDOWS AND DOORS.

WINDOWS:
PELLA WOOD CASEMENT WINDOWS TO BE USED THROUGH OUT.
O = OPERABLE
F = FIXED

FRONT DOOR:
PELLA GLASS DOOR

A 1st FLOOR PLAN
SCALE: 1/4" = 1'-0"

AREA FOOTAGES
2,538 SQ. FT.

REGISTERED ARCHITECT WILLIAM C. PECK 18501 STATE OF TEXAS
05-15-09

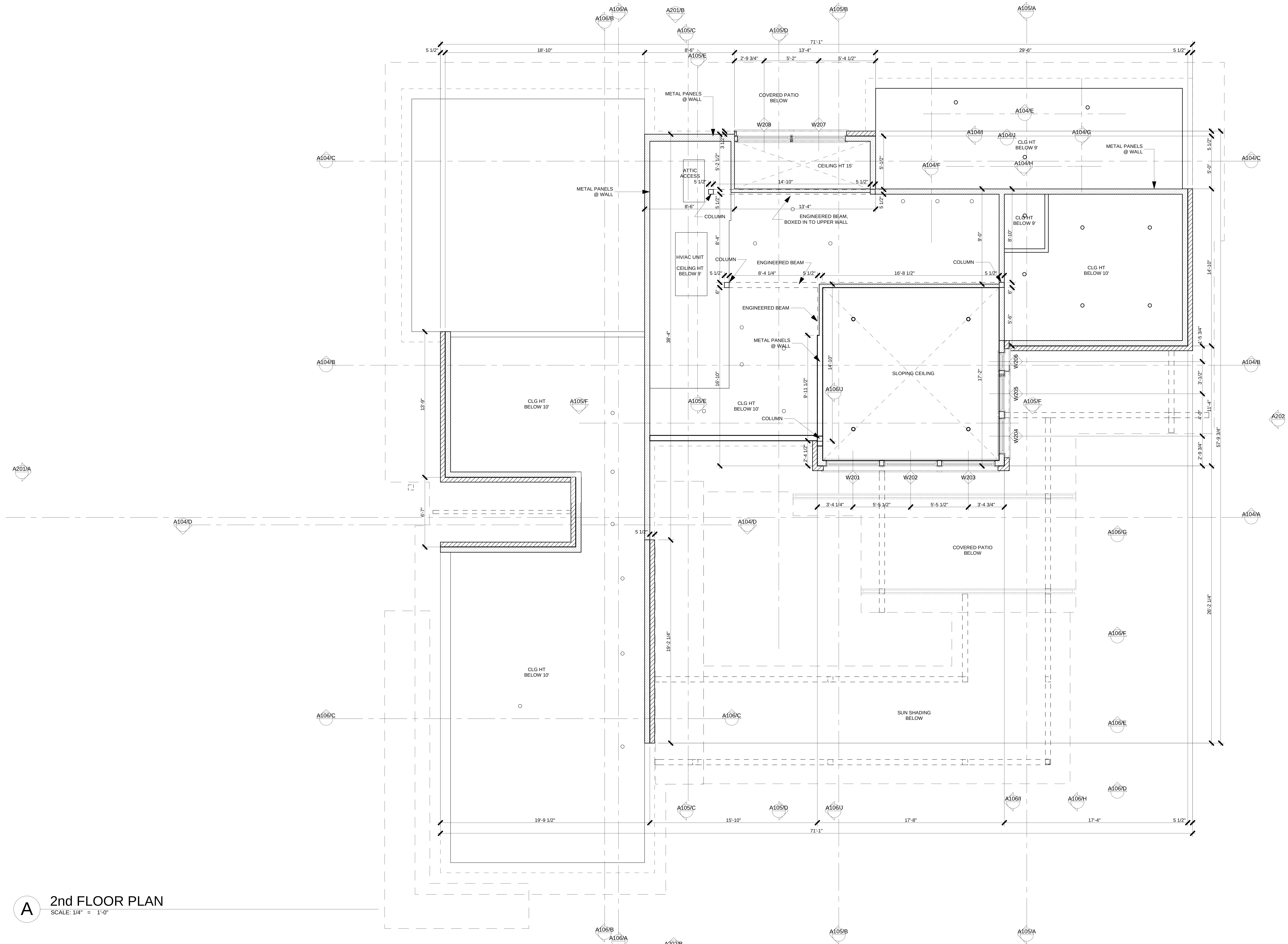
937 TIMBER CREEK DR.,
LEWISVILLE, TEXAS.

WILLIAM PECK &
ASSOCIATES INC.
ARCHITECTS
Lewisville, Tx
(972) 221-1424

1st FLOOR PLAN

REVISIONS
DATE
1 05-15-09

Date: 04-29-09
Scale:
Drawn:
Job:
Sheet Number:
A-101
SHEET 4 OF 26



A 2nd FLOOR PLAN
SCALE: 1/4" = 1'-0"

REGISTERED ARCHITECT
WILLIAM C. PECK
18501
STATE OF TEXAS
05-15-09

These plans are intended to provide the basic construction information necessary to substantially complete this structure. These construction documents must be verified and checked by the builder or person in authority of this project. Any discrepancy, error, and or omissions, if any, are to be brought to the attention of the Designer prior to any construction or purchases being made. It is recommended that the owner or builder obtain complete engineering services for foundation, HVAC, and structural prior to construction of any kind.
NOTE: All Federal, state, and Local codes, ordinances, and restrictions take precedence over any part of these construction documents which may conflict with same, and must be strictly obeyed and followed before and during construction.

937 TIMBER CREEK DR.,
LEWISVILLE, TEXAS.

WILLIAM PECK &
ASSOCIATES INC.
ARCHITECTS
Lewisville, Tx
(972) 221-1424

2nd FLOOR PLAN

REVISIONS
DATE
1 05-15-09

Date: 04-29-09
Scale:
Drawn:
Job:
Sheet Number:
A-102
SHEET 5 OF 26

ROOM FINISH SCHEDULE

NO.	ROOM NAME	FLOOR 1 CERAMIC TILE	FLOOR 2 STAINED CONCRETE	FLOOR 3 WOOD	FLOOR 4 CARPET	FLOOR 5 CONCRETE	FLOOR 6 UNFINISHED PLYWOOD	FLOOR 7 COMP. DECKING / PAVERS	BASE 1 4"	BASE 1 6"	WALLS 1 TEXTURE & PAINT	WALLS 2 TILE	WALLS 3	WALLS 4	WALLS 5	WALLS 6	CEILING 1 PAINTED DRYWALL	CEILING 2 OPEN ROOF DECK	CEILING 3 LATTICE AWNING	CEILING 4	CEILING 5	CROWN 1 4" CLEAR STAINED BIRCH	CROWN 2 4" PAINTED	CROWN 3	CLG. HT.	REMARKS
101	ENTRANCE		X							X	X	X					X								10'	
102	HALL		X						X			X					X								10'	
103	BEDROOM 1				X				X			X					X								10'	
104	CLOSET 1				X				X			X					X								10'	
105	BATHROOM 1	X							X			X	X				X								10'	
106	BEDROOM 2				X				X			X					X								10'	
107	CLOSET 2				X				X			X					X								10'	
108	STUDY		X							X		X					X								10'	
109	PWDR ROOM	X								X		X	X				X								10'	
110	UTILITY	X							X			X					X								9'	
111	MUDROOM		X						X			X					X								9'	
112	PANTRY	X							X			X					X								9'	
113	KITCHEN		X						X			X	X				X								10'	
114	DINING ROOM		X							X		X					X								SLOPING 11 TO 13	
115	FAMILY ROOM		X							X		X					X								10'	
116	VESTIBULE		X							X		X					X								10'	
117	MASTER BEDRM				X					X		X					X								10'	
118	HALL 2	X							X			X					X								10'	
119	MASTER BATHROOM	X							X			X	X				X								10'	
120	MASTER CLOSET 1				X				X			X					X								10'	
121	MASTER CLOSET 2				X				X			X					X								10'	
122	GARAGE					X						X					X								9'-3"	
123	COVERED FRONT PORCH							X											X							
124	BACK PORCH							X										X	X							
125	GRILL PATIO							X										X								
201	ATTIC / TEHCNICAL SPACE						X												X							

C ROOM FINISH SCHEDULE

SCALE: 1:0.74

WINDOW SCHEDULE

MARK	SIZE WIDTH	SIZE HEIGHT	W/D nomi...	TYPE	HT HORIZ. DIVISION	MATERIAL	NOTES
W101	3'-0"	6'-6"	8'-0"	W1 Casement FixU 12	5'-0"	FIBERGLASS WINDOW	W101-102 TRIMMED (STRIPED) TOGETHER
W102	3'-0"	6'-6"	8'-0"	W1 Casement FixU 12	5'-0"	FIBERGLASS WINDOW	W101-102 TRIMMED (STRIPED) TOGETHER
W103	1'-8"	8'-0"	8'-0"	W1 Casement FixU 12	6'-6"	FIBERGLASS WINDOW	
W104	5'-0"	1'-8"	8'-0"	W Fixed 12		FIBERGLASS WINDOW	W103-104 TRIMMED (STRIPED) TOGETHER
W105	5'-0"	1'-8"	8'-0"	W Fixed 12		FIBERGLASS WINDOW	W103-104 TRIMMED (STRIPED) TOGETHER
W106	3'-0"	6'-6"	8'-0"	W1 Casement FixU 12	5'-0"	FIBERGLASS WINDOW	OPERABLE CASEM. 3'-0" X 5'-0" = EGRESS
W107	5'-0"	1'-8"	8'-0"	W Fixed 12		FIBERGLASS WINDOW	W106-109 TRIMMED (STRIPED) TOGETHER
W108	5'-0"	1'-8"	8'-0"	W Fixed 12		FIBERGLASS WINDOW	W106-109 TRIMMED (STRIPED) TOGETHER
W109	3'-0"	6'-6"	8'-0"	W1 Casement FixU 12	5'-0"	FIBERGLASS WINDOW	OPERABLE CASEM. 3'-0" X 5'-0" = EGRESS
W110	3'-0"	6'-6"	8'-0"	W1 Casement FixU 12	5'-0"	FIBERGLASS WINDOW	OPERABLE CASEM. 3'-0" X 5'-0" = EGRESS
W111	4'-0"	7'-0"	8'-0"	W Fixed AwnU 12	2'-0"	FIBERGLASS WINDOW	W111-112 TRIMMED (STRIPED) TOGETHER
W112	4'-0"	7'-0"	8'-0"	W Fixed AwnU 12	2'-0"	FIBERGLASS WINDOW	W111-112 TRIMMED (STRIPED) TOGETHER
W113	4'-0"	7'-0"	8'-0"	W Fixed AwnU 12	2'-0"	FIBERGLASS WINDOW	W113-114 TRIMMED (STRIPED) TOGETHER
W114	4'-0"	7'-0"	8'-0"	W Fixed AwnU 12	2'-0"	FIBERGLASS WINDOW	W113-114 TRIMMED (STRIPED) TOGETHER
W115	3'-8"	7'-0"	8'-0"	W Fixed AwnU 12	2'-0"	FIBERGLASS WINDOW	
W116	3'-8"	7'-0"	8'-0"	W Fixed AwnU 12	2'-0"	FIBERGLASS WINDOW	
W117	5'-0"	7'-0"	8'-0"	W Fixed AwnU 12	2'-0"	FIBERGLASS WINDOW	
W118	5'-0"	7'-0"	8'-0"	W Fixed AwnU 12	2'-0"	FIBERGLASS WINDOW	
W119	1'-8"	7'-0"	8'-0"	W Fixed AwnU 12	2'-0"	FIBERGLASS WINDOW	
W120	1'-10"	5'-0"	8'-0"	W Fixed 12		FIBERGLASS WINDOW	
W121	3'-0"	6'-6"	8'-0"	W1 Casement FixU 12	4'-6"	FIBERGLASS WINDOW	W121-122 TRIMMED TOGETHER, OPEARBLE WIN 3'-0"X5'-0" = EGRESS
W122	3'-0"	6'-6"	8'-0"	W1 Casement FixU 12	4'-6"	FIBERGLASS WINDOW	W121-122 TRIMMED TOGETHER, OPEARBLE WIN 3'-0"X5'-0" = EGRESS
W123	1'-6"	5'-0"	8'-0"	W Fixed 12		FIBERGLASS WINDOW	
W124	1'-6"	5'-0"	8'-0"	W Fixed 12		FIBERGLASS WINDOW	
W125	1'-6"	5'-0"	8'-0"	W Fixed 12		FIBERGLASS WINDOW	
W126	5'-0"	1'-6"	8'-0"	W Fixed 12		FIBERGLASS WINDOW	W126-129 TRIMMED (STRIPED) TOGETHER
W127	3'-0"	5'-0"	8'-0"	W1 Casement AwnL 12	1'-6"	FIBERGLASS WINDOW	W126-129 TRIMMED (STRIPED) TOGETHER
W128	3'-0"	5'-0"	8'-0"	W1 Casement AwnL 12	1'-6"	FIBERGLASS WINDOW	W126-129 TRIMMED (STRIPED) TOGETHER
W129	5'-0"	1'-6"	8'-0"	W Fixed 12		FIBERGLASS WINDOW	W126-129 TRIMMED (STRIPED) TOGETHER
W130	1'-6"	5'-0"	8'-0"	W Fixed 12		FIBERGLASS WINDOW	
W131	3'-2"	1'-6"	4'-4"	W Fixed 12		FIBERGLASS WINDOW	W131-134 TRIMMED (STRIPED) TOGETHER
W132	3'-2"	1'-6"	4'-4"	W Fixed 12		FIBERGLASS WINDOW	W131-134 TRIMMED (STRIPED) TOGETHER
W133	3'-2"	1'-6"	4'-4"	W Fixed 12		FIBERGLASS WINDOW	W131-134 TRIMMED (STRIPED) TOGETHER
W134	3'-2"	1'-6"	4'-4"	W Fixed 12		FIBERGLASS WINDOW	W131-134 TRIMMED (STRIPED) TOGETHER
W135	5'-0"	1'-8"	8'-0"	W Fixed 12		FIBERGLASS WINDOW	W135-137 TRIMMED (STRIPED) TOGETHER
W136	5'-0"	1'-8"	8'-0"	W Fixed 12		FIBERGLASS WINDOW	W135-137 TRIMMED (STRIPED) TOGETHER
W137	5'-0"	1'-8"	8'-0"	W Fixed 12		FIBERGLASS WINDOW	W135-137 TRIMMED (STRIPED) TOGETHER
W201	5'-0"	2'-0"	10'-0"	W Fixed 12		FIBERGLASS WINDOW	HEADER TO 1ST FLOOR 10'-0"
W202	5'-0"	2'-0"	10'-0"	W Fixed 12		FIBERGLASS WINDOW	HEADER TO 1ST FLOOR 10'-0"
W203	5'-0"	2'-0"	10'-0"	W Fixed 12		FIBERGLASS WINDOW	HEADER TO 1ST FLOOR 10'-0"
W204	3'-4"	2'-0"	10'-0"	W Fixed 12		FIBERGLASS WINDOW	HEADER TO 1ST FLOOR 10'-0"
W205	3'-4"	2'-0"	10'-0"	W Fixed 12		FIBERGLASS WINDOW	HEADER TO 1ST FLOOR 10'-0"
W206	1'-8"	2'-0"	10'-0"	W Fixed 12		FIBERGLASS WINDOW	HEADER TO 1ST FLOOR 10'-0"
W207	5'-0"	2'-6"	14'-0"	W Fixed 12		FIBERGLASS WINDOW	HEADER TO 1ST FLOOR 14'-0"
W208	5'-0"	2'-6"	14'-0"	W Fixed 12		FIBERGLASS WINDOW	HEADER TO 1ST FLOOR 14'-0"

B WINDOW SCHEDULE

SCALE: 1' = 1'-0"

DOOR AND FRAME SCHEDULE

MARK	DOOR SIZE W	DOOR SIZE HT	DOOR MATL	DOOR PANEL	DOOR GLZ	DOOR LOUVER W	DOOR LOUVER HT	FRAME MATL	FRAME	HARDWARE SET NO	HARDWARE KEYSIDE RM NO	NOTES
D101	3'-0"	8'-0"	---	GLASS	DBL							MAIN DOOR SGL DOOR
D102	3'-0"	8'-0"	---	SOLID	---							BEDRM SGL DOOR
D103	2'-6"	8'-0"	---	HOLLOW / SOLID								CLOSET SGL DOOR
D104	2'-6"	8'-0"	---	SOLID	---							BATHRM SGL DOOR
D105	2'-10"	8'-0"	---	HOLLOW / SOLID	---							BATHRM SGL DOOR
D106	3'-0"	8'-0"	---	SOLID	---							BEDRM SGL DOOR
D107	2'-6"	8'-0"	---	HOLLOW / SOLID	---							CLOSET SGL DOOR
D108	4'-0"	8'-0"	---	HOLLOW	---							CLOSET DBL DOOR
D109	3'-0"	8'-0"	---	GLASS	DBL							PATIO SGL GLASS DOOR
D110	6'-0"	8'-0"	---	GLASS	SGL							STUDY DBL DOOR UNIT
D111	3'-0"	8'-0"	---	SOLID	---							PWDR SGL DOOR
D112	3'-0"	8'-0"	---	SOLID	---							UTILITY SGL DOOR
D113	3'-0"	8'-0"	---	SOLID	---							UTILITY SGL DOOR
D114	3'-0"	8'-0"	---	SOLID	---							GARAGE SGL DOOR
D115	2'-6"	8'-0"	---	SOLID	---							PANTRY SGL DOOR
D116	3'-0"	8'-0"	---	SOLID	---							MUD ROOM SLIDING POCKET DOOR
D117	3'-0"	8'-0"	---	GLASS	DBL							PATIO SGL DOOR W/ 1'-8" TRANSOM
D118	6'-0"	8'-0"	---	GLASS	DBL							PATIO DBL GLASS DOOR UNIT
D119	3'-0"	8'-0"	---	SOLID	---							BEDRM SGL DOOR
D120	3'-0"	8'-0"	---	SOLID	---							BEDRM SGL DOOR TO BATHRM
D121	2'-6"	8'-0"	---	SOLID	---							MASTER CLOSET SGL DOOR
D122	2'-6"	8'-0"	---	SOLID	---							TOILET RM SGL DOOR
D123	2'-6"	8'-0"	---	SOLID	---							MASTER CLOSET SGL DOOR
D124	3'-0"	8'-0"	---	SOLID	---							HALL SLIDING DOOR EXT
D125	9'-0"	8'-0"	---	METAL	---							GARAGE O.H. DOOR
D126	9'-0"	8'-0"	---	METAL	---							GARAGE O.H. DOOR
OPENING 1	3'-0"	8'-0"	---		---							OPENING 1

A DOOR SCHEDULE

SCALE: 1' = 1'-0"

REGISTERED ARCHITECT WILLIAM C. PECK 18501 STATE OF TEXAS

05-15-09

937 TIMBER CREEK DR.,
LEWISVILLE, TEXAS.

WILLIAM PECK & ASSOCIATES INC. ARCHITECTS
Lewisville, Tx
(972) 221-1424

SCHEDULES

REVISIONS	
DATE	
1	05-15-09

Date: 04-29-09

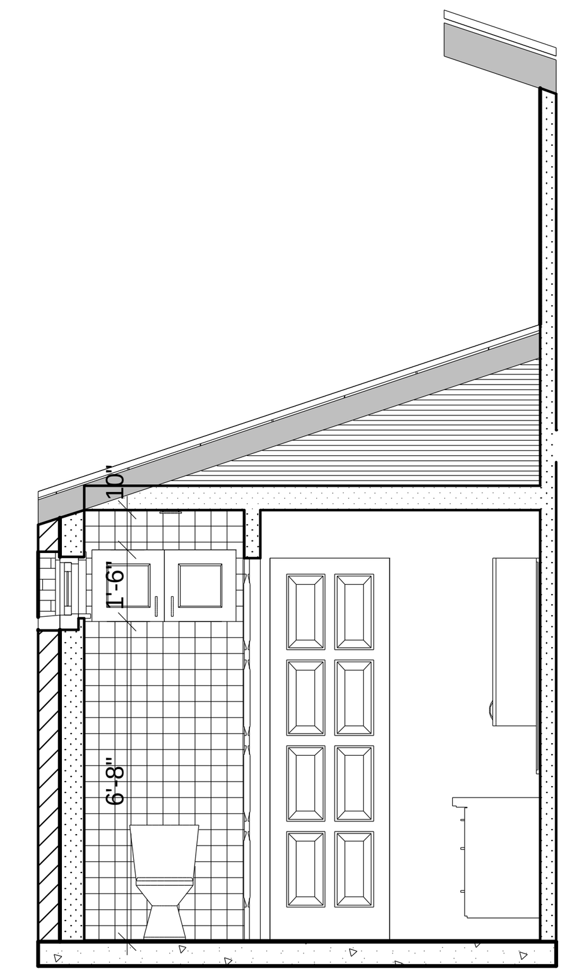
Scale:

Drawn:

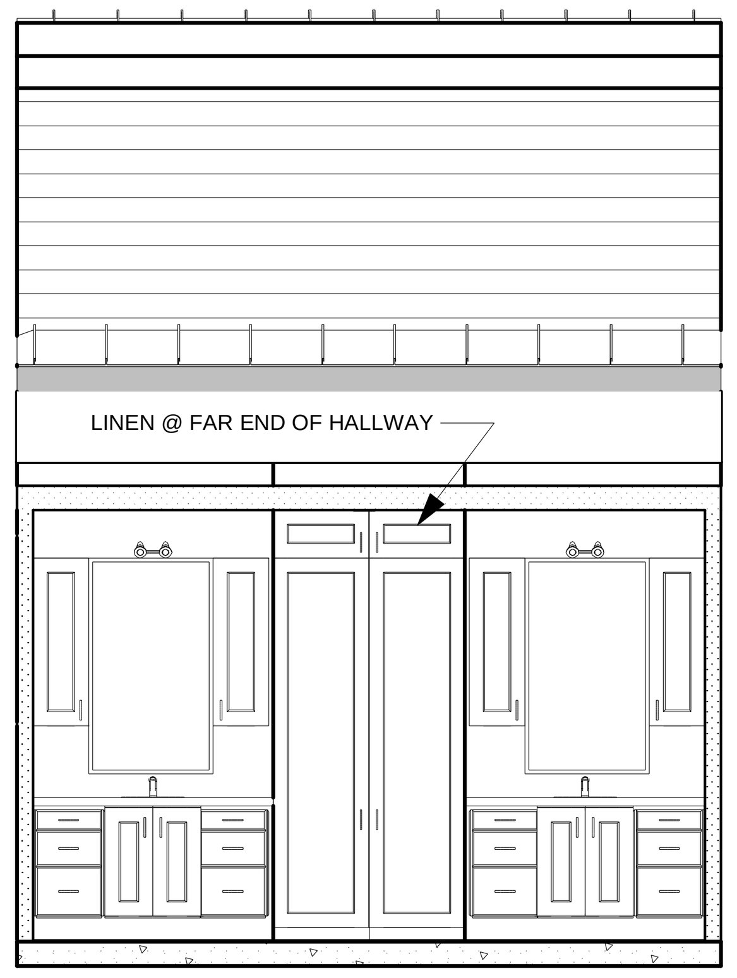
Job:

Sheet Number: A-103

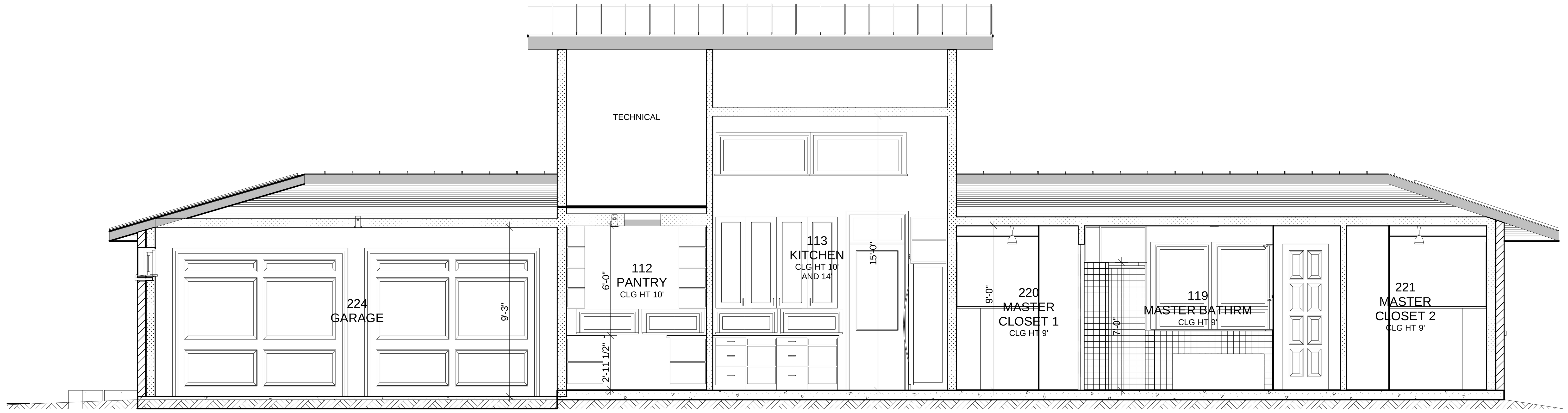
SHEET 6 OF 26



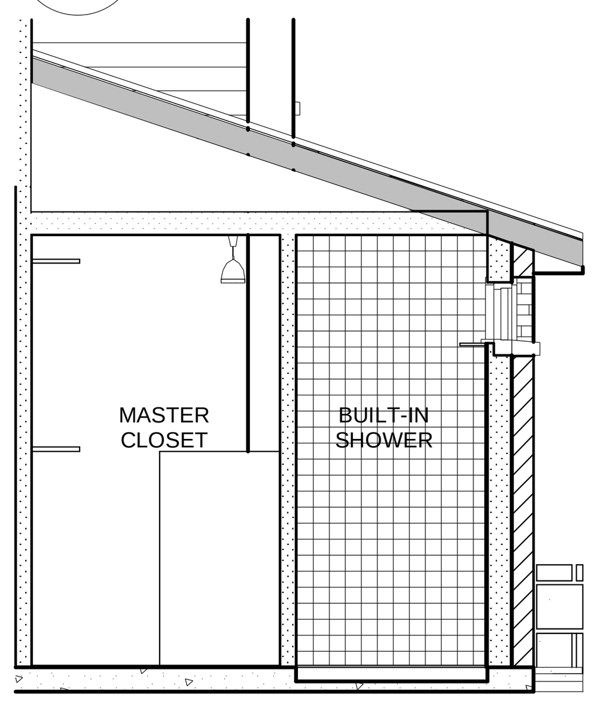
G A104/G SECTION
SCALE: 1/4" = 1'-0"



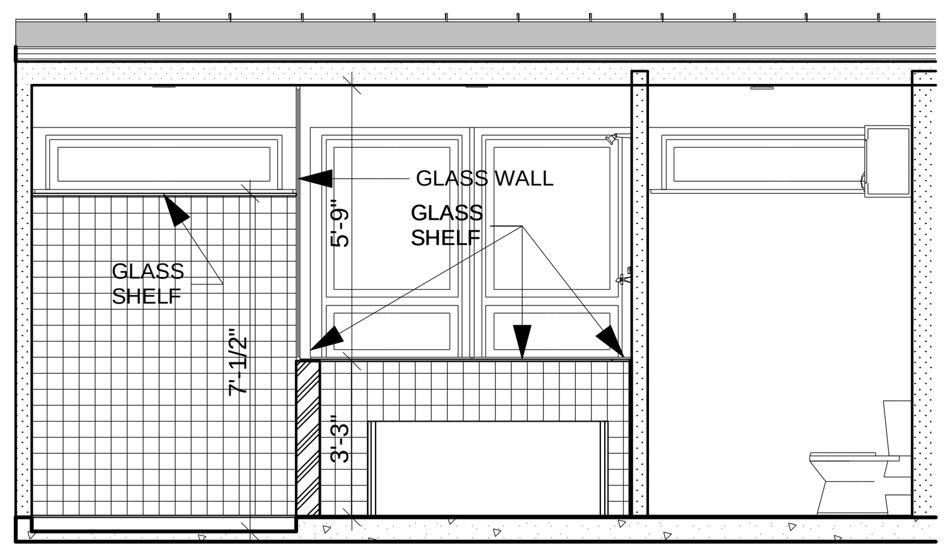
H A104/H SECTION
SCALE: 1/4" = 1'-0"



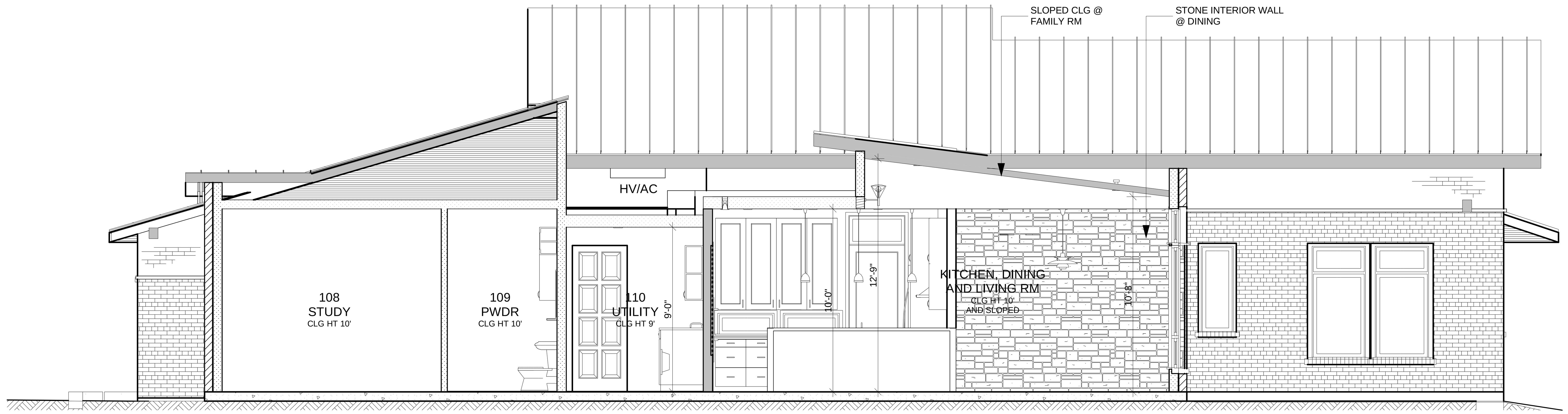
C A104/C SECTION
SCALE: 1/4" = 1'-0"



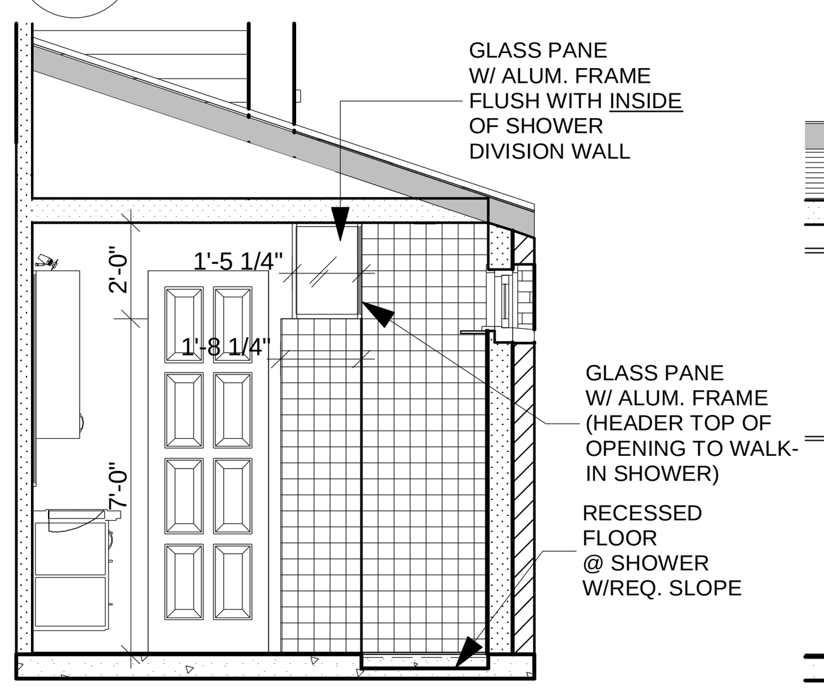
F A104/F SECTION
SCALE: 1/4" = 1'-0"



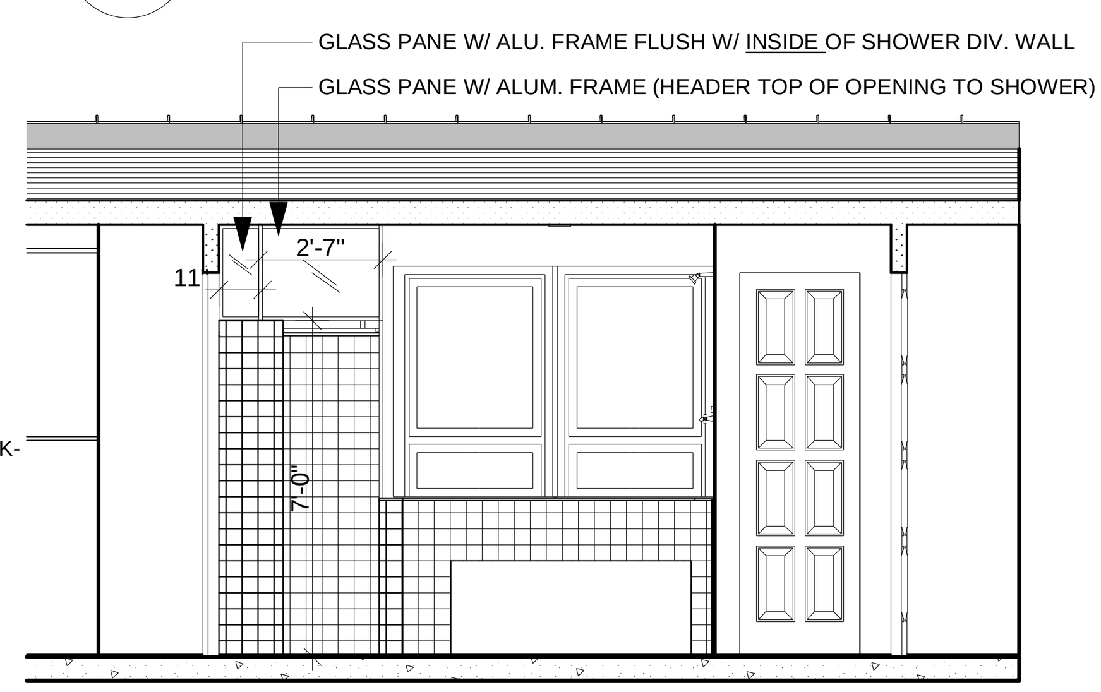
E A104/E SECTION
SCALE: 1/4" = 1'-0"



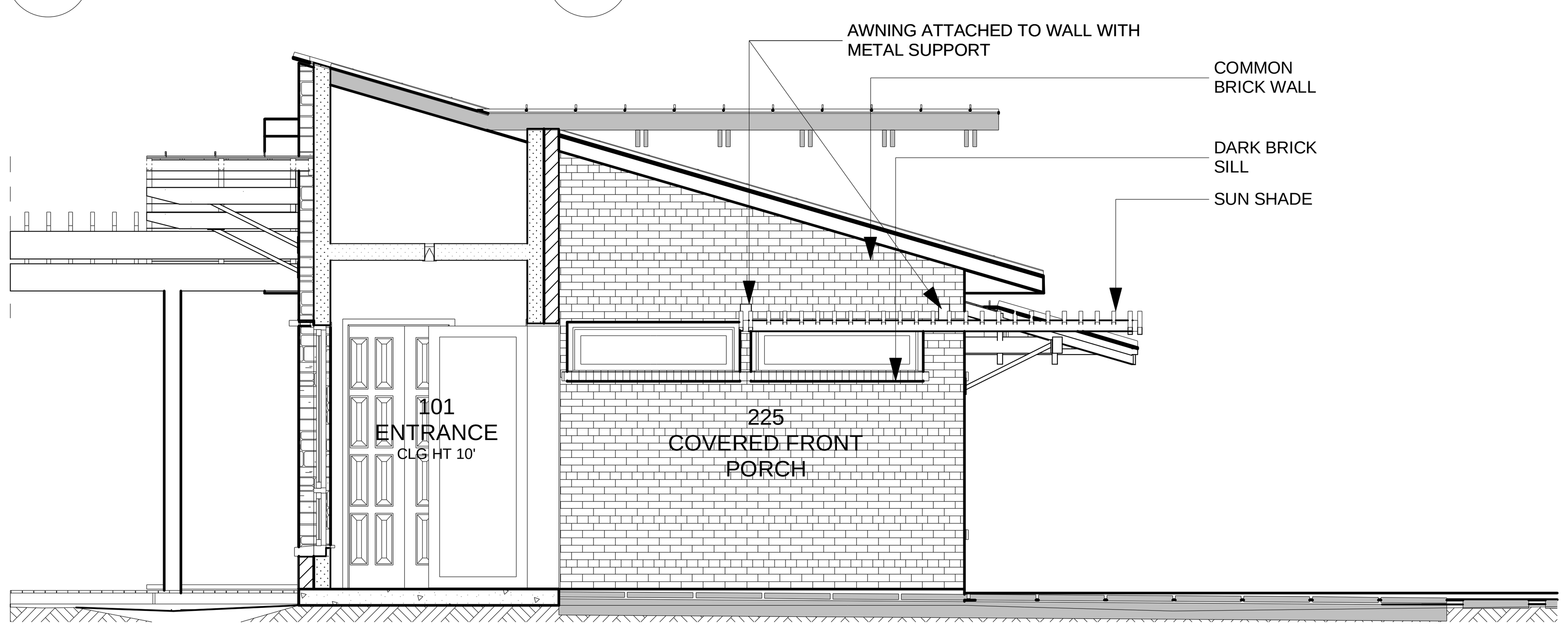
B A104/B SECTION
SCALE: 1/4" = 1'-0"



I A104/I SECTION
SCALE: 1/4" = 1'-0"



J A104/J SECTION
SCALE: 1/4" = 1'-0"



D A104/D SECTION, FRONT ENTRANCE ELEVATION
SCALE: 1/4" = 1'-0"

A A104/A SECTION, ENTRANCE ELEVATION
SCALE: 1/4" = 1'-0"

REGISTERED ARCHITECT
WILLIAM C. PECK
18501
STATE OF TEXAS
05-15-09

These plans are intended to provide the basic construction information necessary to substantially complete this structure. These construction documents must be verified and checked by the builder or person in authority of this project. Any discrepancy, error, and/or omissions, if any, are to be brought to the attention of the Designer prior to any construction or purchases being made. It is recommended that the owner or builder obtain complete engineering services for foundation, HVAC, and structural prior to construction of any kind. NOTE: All Federal, state, and Local codes, ordinances, and restrictions take precedence over any part of these construction documents which may conflict with same, and must be strictly obeyed and followed before and during construction.

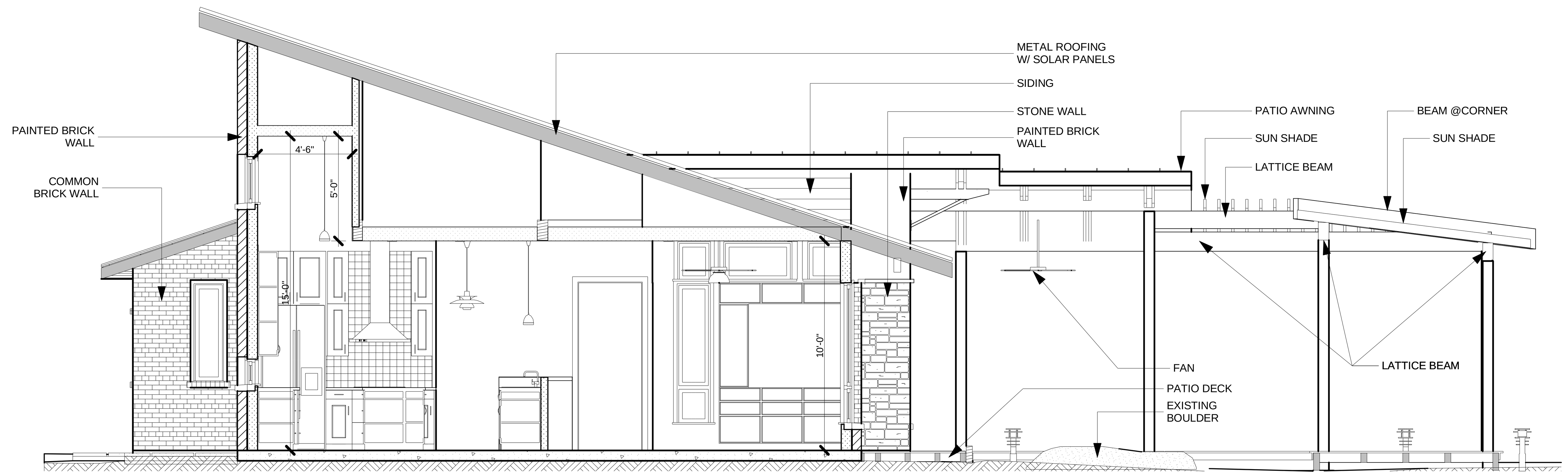
937 TIMBER CREEK DR.,
LEWISVILLE, TEXAS.

WILLIAM PECK &
ASSOCIATES INC.
ARCHITECTS
(972) 221-1424
Lewisville, Tx

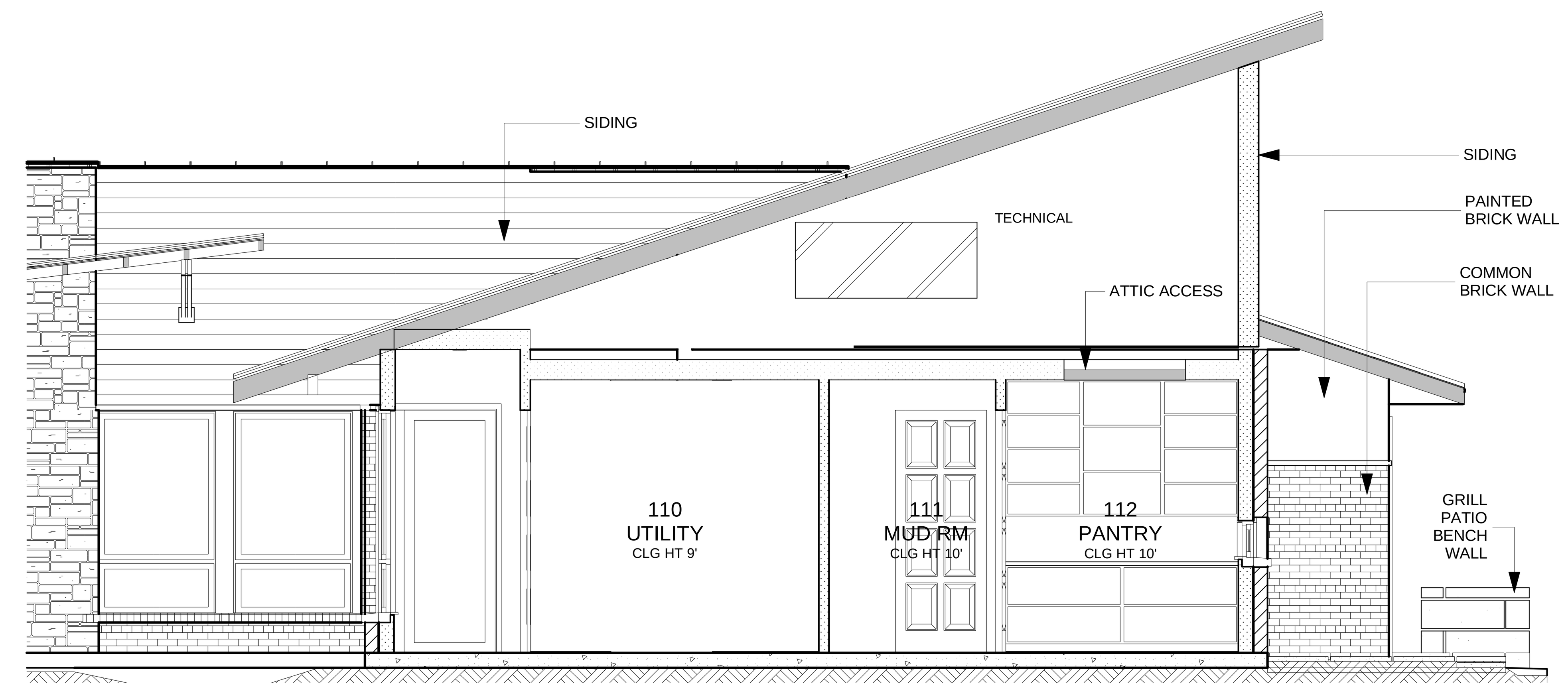
SECTIONS

REVISIONS
DATE
1 05-15-09

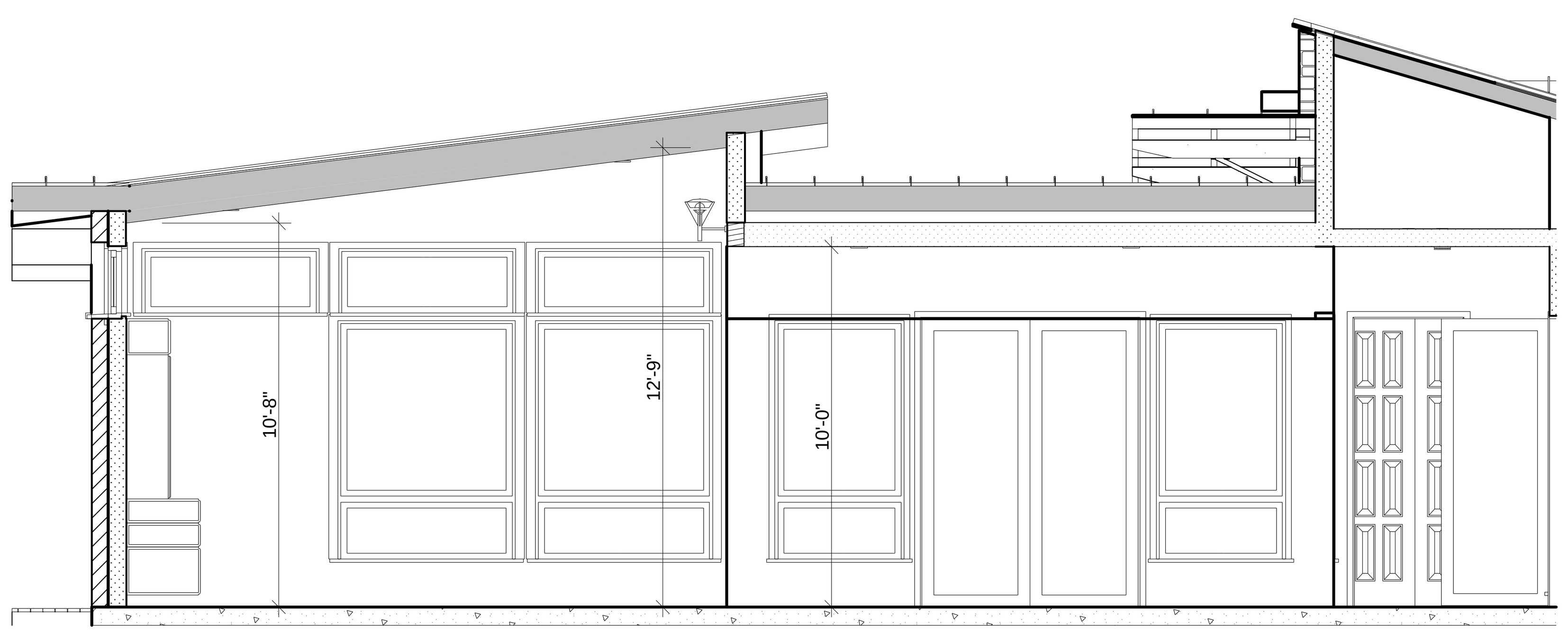
Date: 04-29-09
Scale:
Drawn:
Job:
Sheet Number:
A-104
SHEET 7 OF 26



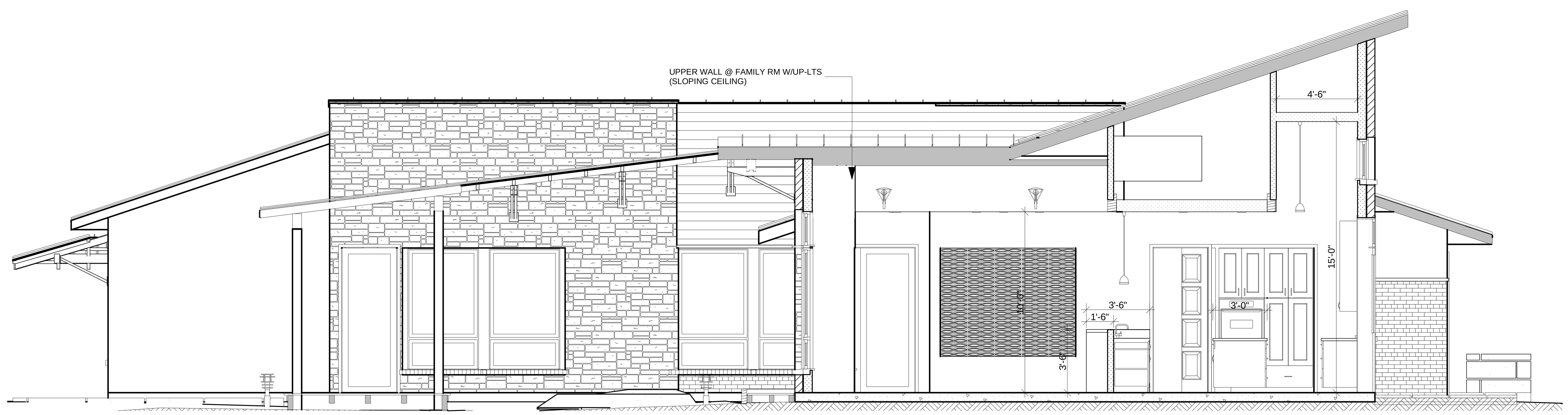
D A105/D SECTION, HIDDEN ELEVATIONS (GRILL & BACK PORCH)
SCALE: 1/4" = 1'-0"



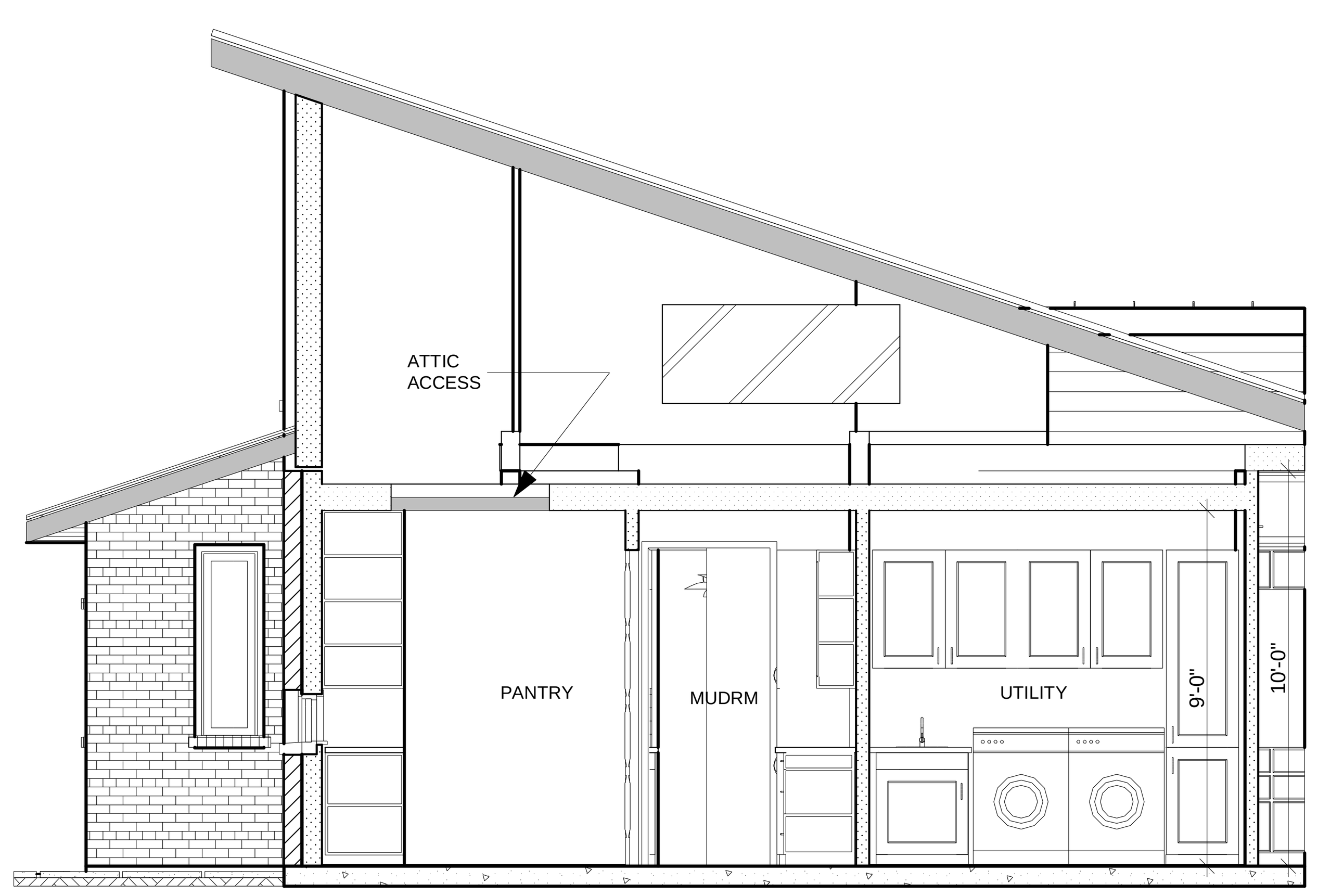
C A105/C SECTION, HIDDEN ELEVATIONS (GRILL & BACK PORCH)
SCALE: 1/4" = 1'-0"



F A105/F GREAT RM
SCALE: 1/4" = 1'-0"



B A105/B SECTION
SCALE: 1/4" = 1'-0"



E A105/E PANTRY&MUD&UTILITY
SCALE: 1/4" = 1'-0"

A A105/A SECTION
SCALE: 1/4" = 1'-0"

REGISTERED ARCHITECT
WILLIAM C. PECK
18501
STATE OF TEXAS
05-15-09

These plans are intended to provide the basic construction information necessary to substantially complete this structure. These construction documents must be verified and checked by the builder or person in authority of this project. Any discrepancy, error, and/ or omissions, if any, are to be brought to the attention of the Designer prior to any construction or purchases being made. It is recommended that the owner or builder obtain complete engineering services for: foundation, HVAC, and structural, prior to construction of any kind.
NOTE: All Federal, state, and Local codes, ordinances, and restrictions take precedence over any part of these construction documents which may conflict with same, and must be strictly obeyed and followed before and during construction.

937 TIMBER CREEK DR.,
LEWISVILLE, TEXAS.

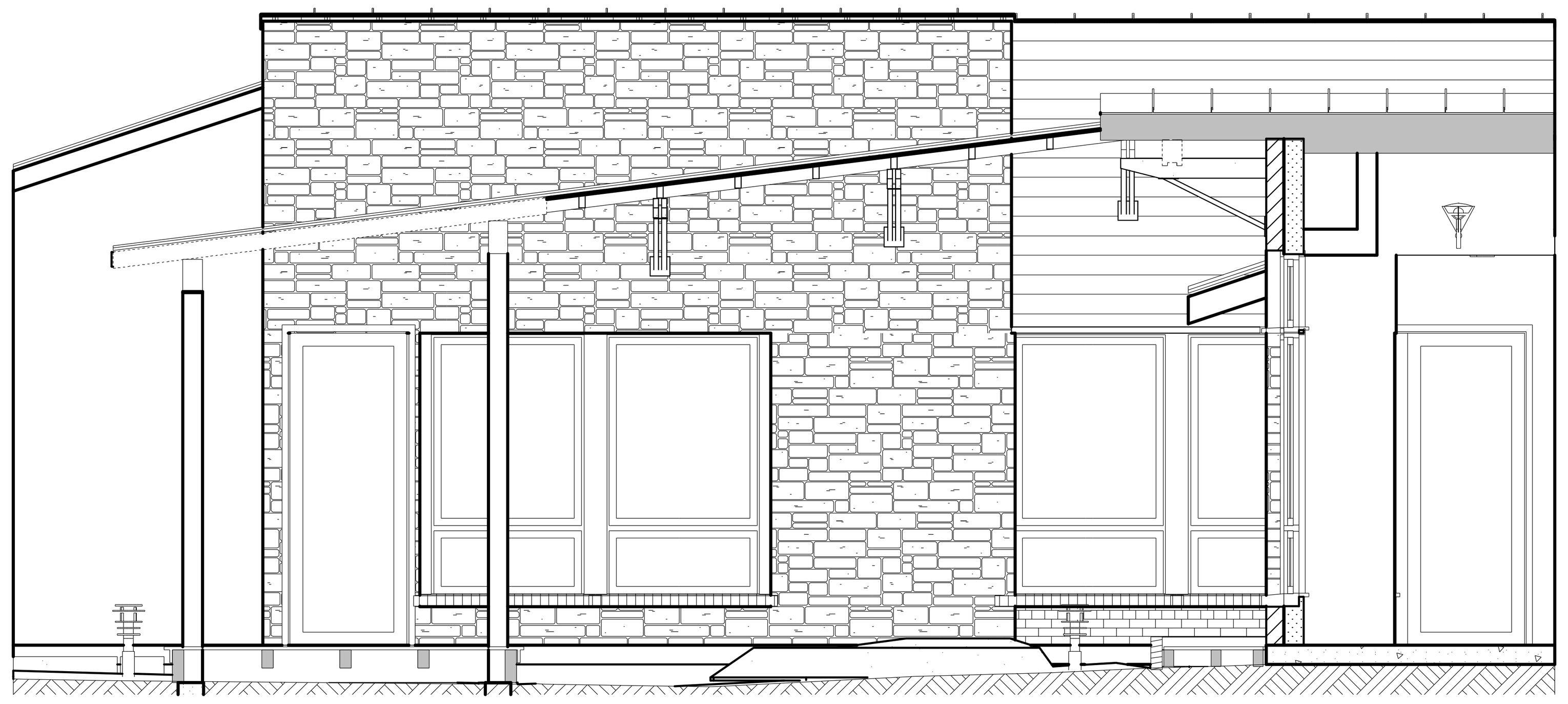
WILLIAM PECK &
ASSOCIATES INC.
ARCHITECTS
Lewisville, Tx
(972) 221-1424

SECTIONS

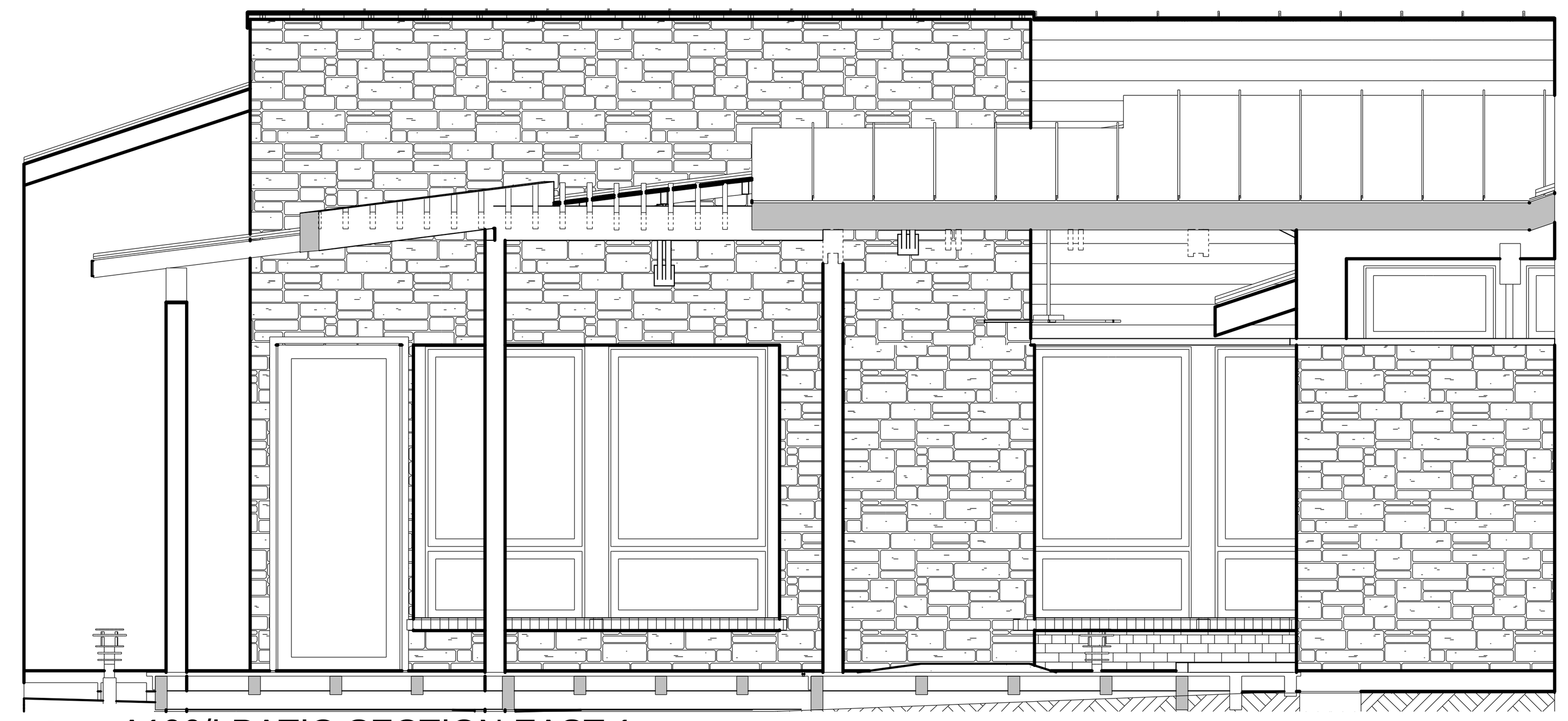
REVISIONS
DATE
1 05-15-09

Date:	04-29-09
Scale:	
Drawn:	
Job:	
Sheet Number:	A-105

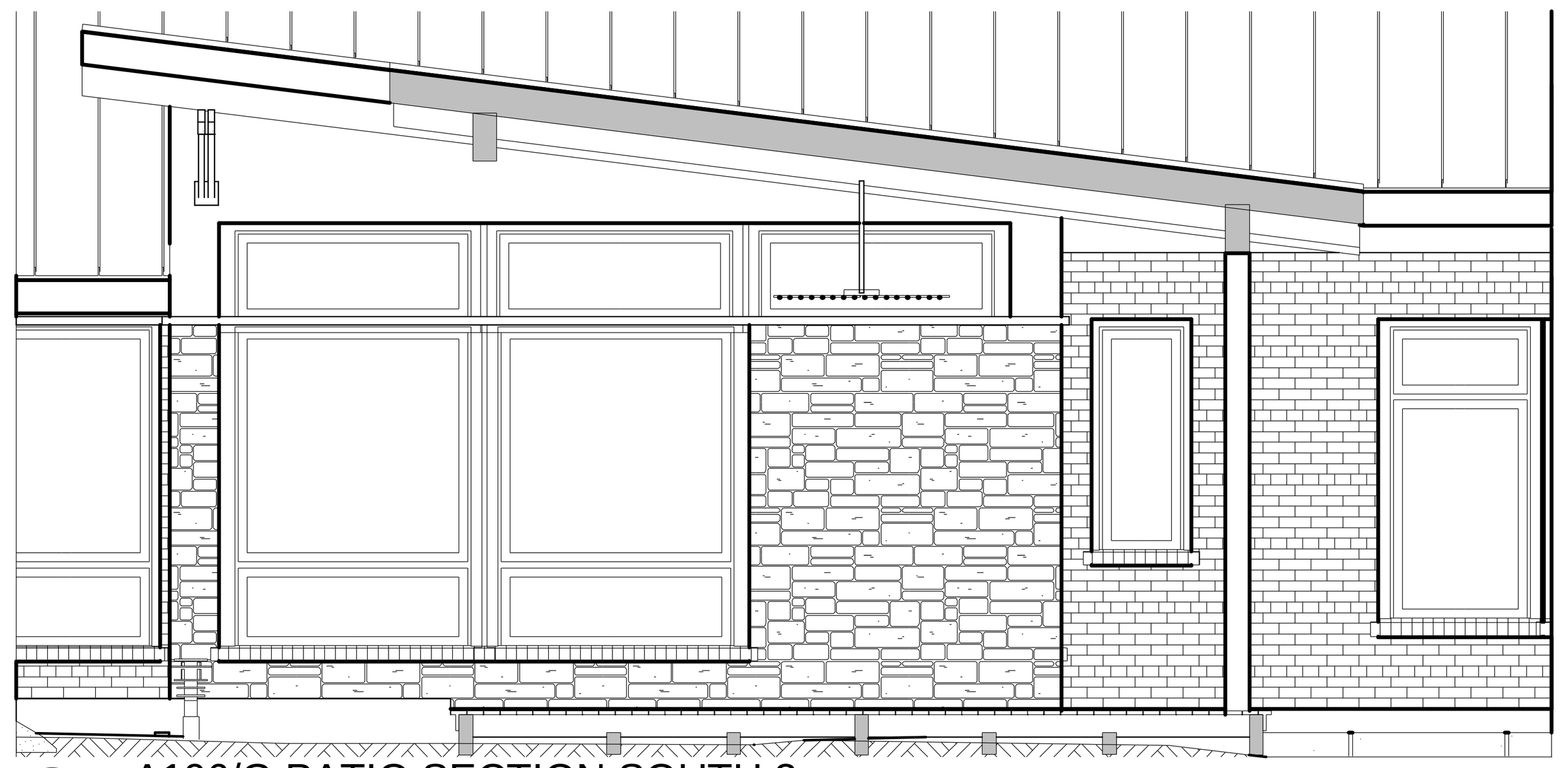
SHEET 8 OF 26



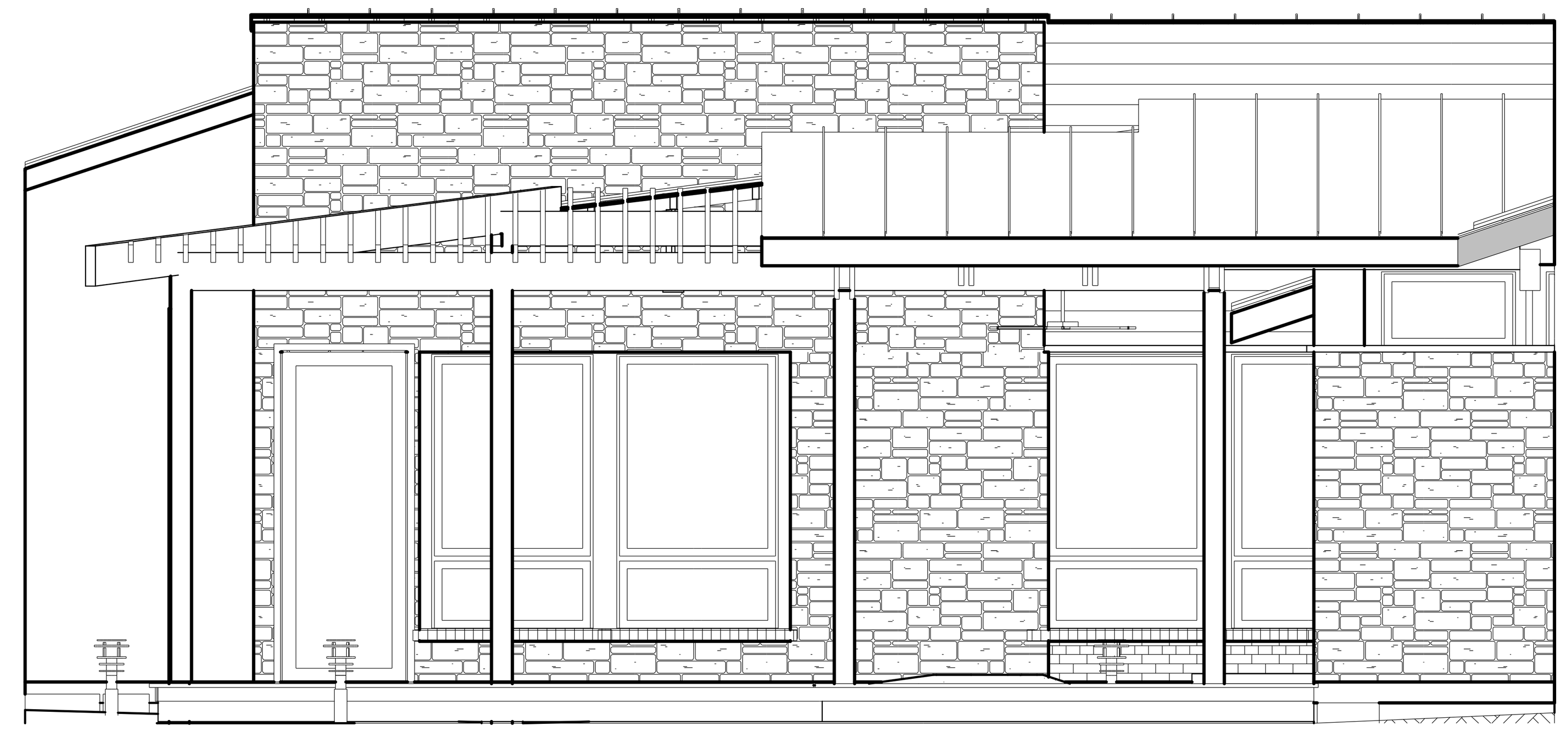
J A106/J PATIO SECTION EAST 2
SCALE: 1/4" = 1'-0"



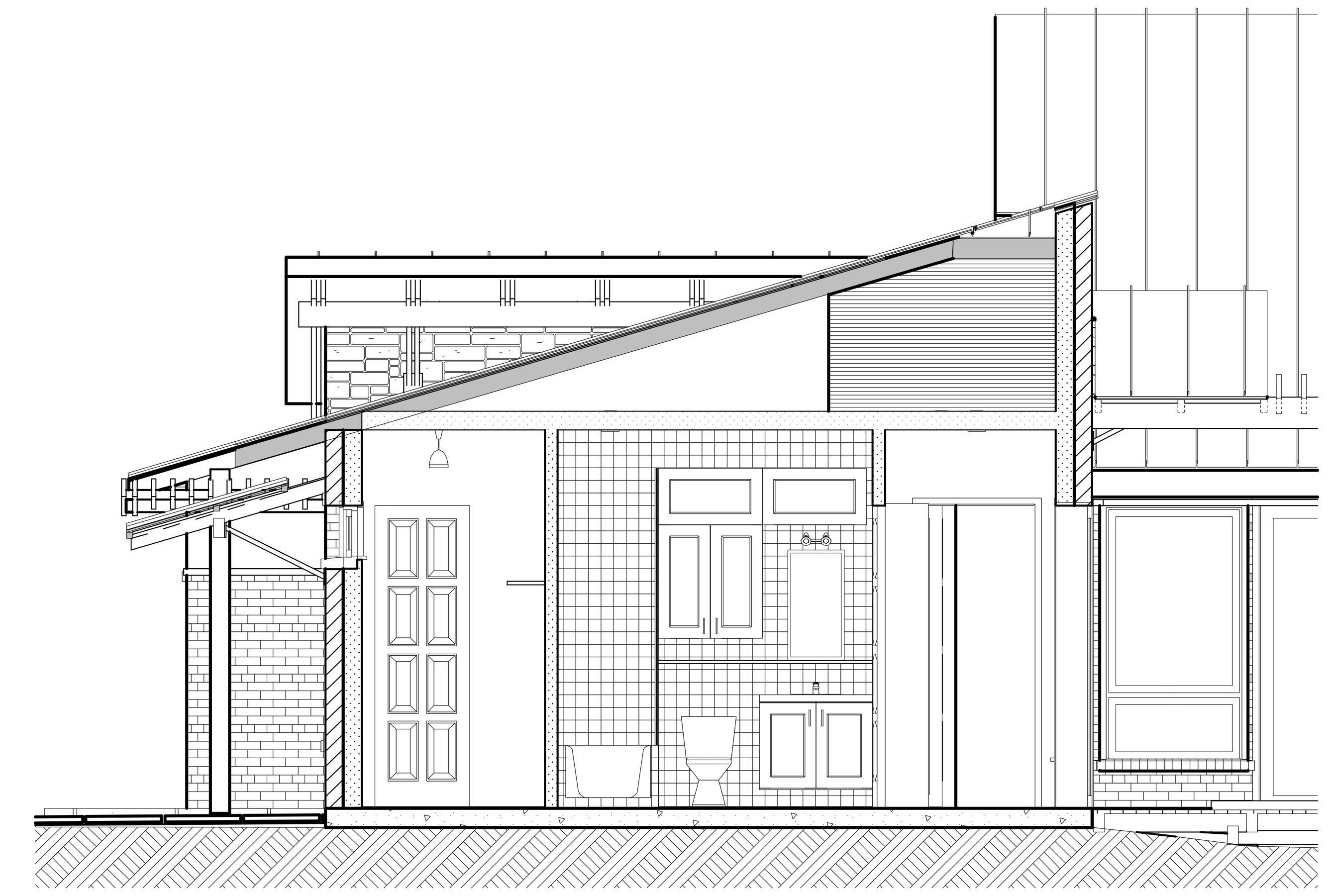
I A106/I PATIO SECTION EAST 1
SCALE: 1/4" = 1'-0"



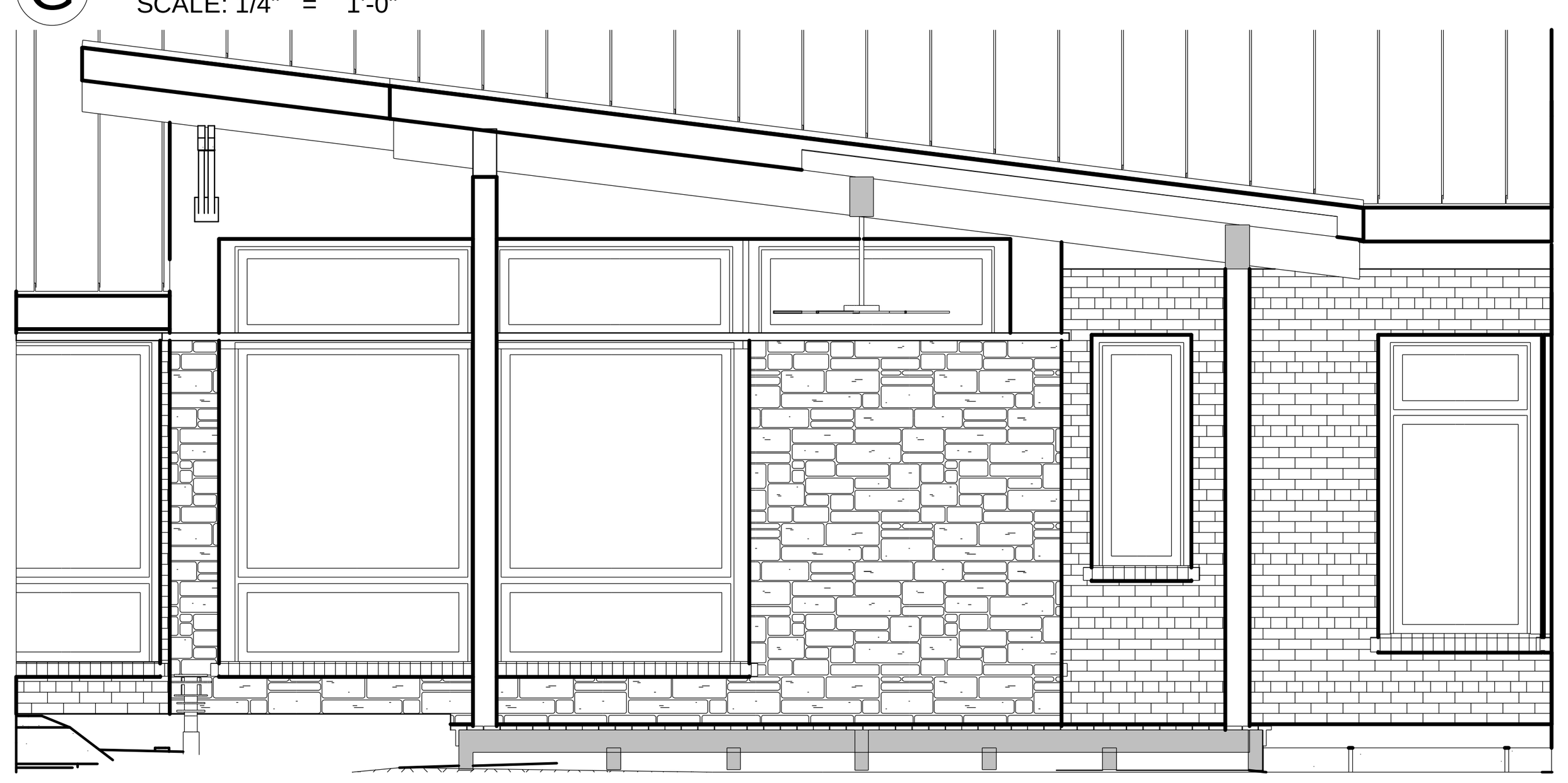
G A106/G PATIO SECTION SOUTH 3
SCALE: 1/4" = 1'-0"



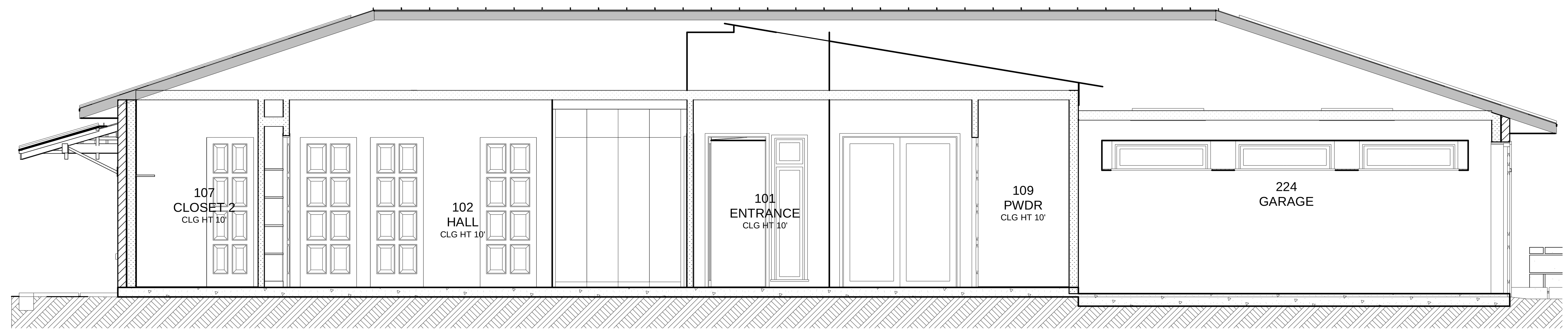
H A106/H PATIO ELEVATION EAST
SCALE: 1/4" = 1'-0"



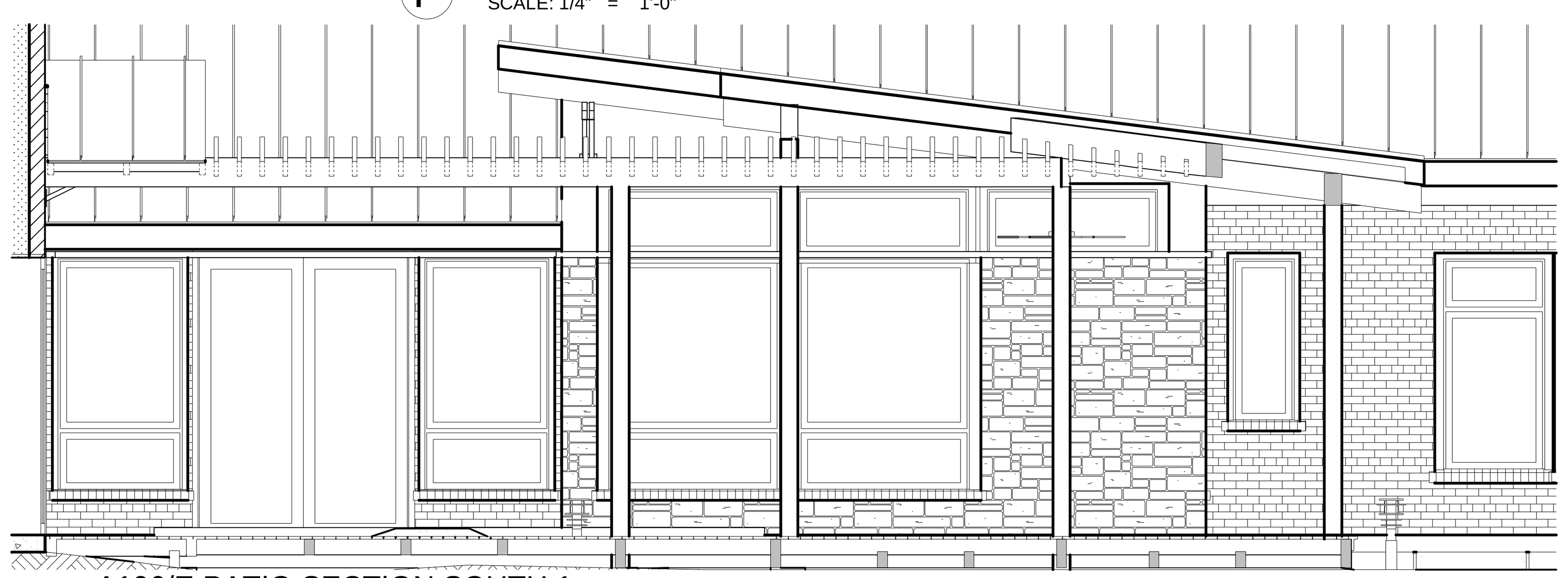
C SECTION BATH & HALL
SCALE: 1/4" = 1'-0"



F A106/F PATIO SECTION SOUTH 2
SCALE: 1/4" = 1'-0"



B A106/B SECTION HALL
SCALE: 1/4" = 1'-0"



E A106/E PATIO SECTION SOUTH 1
SCALE: 1/4" = 1'-0"

A A106/A SECTION HALL
SCALE: 1/4" = 1'-0"

D A106/D PATIO ELEVATION SOUTH
SCALE: 1/4" = 1'-0"

REGISTERED ARCHITECT WILLIAM C. PECK 18501 STATE OF TEXAS
05-15-09

These plans are intended to provide the basic construction information necessary to substantially complete this structure. These construction documents must be verified and checked by the builder or person in authority of this project. Any discrepancy, error, and/ or omissions, if any, are to be brought to the attention of the Designer prior to any construction or purchases being made. It is recommended that the owner or builder obtain complete engineering services for: foundation, HVAC, and structural, prior to construction of any kind. NOTE: All Federal, state, and Local codes, ordinances, and restrictions take precedence over any part of these construction documents which may conflict with same, and must be strictly obeyed and followed before and during construction.

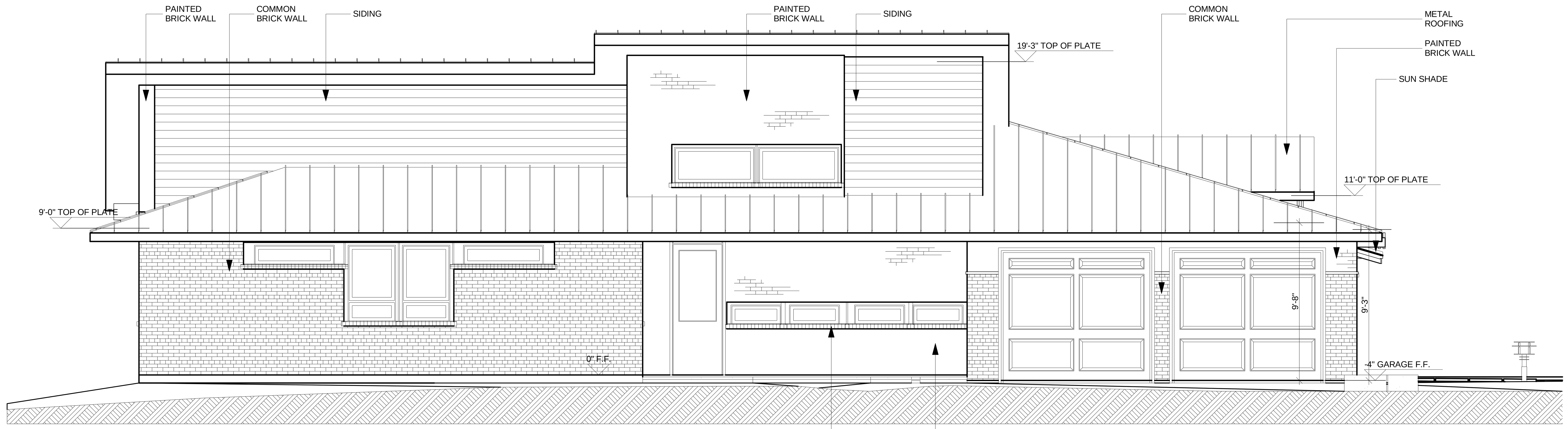
937 TIMBER CREEK DR.,
LEWISVILLE, TEXAS.

WILLIAM PECK &
ASSOCIATES INC.
ARCHITECTS
Lewisville, Tx
(972) 221-1424

SECTIONS

REVISIONS
DATE
1 05-15-09

Date: 04-29-09
Scale:
Drawn:
Job:
Sheet Number:
A-106
SHEET 9 OF 26



MATERIAL CALCULATION

ALL NORTH FACING ELEVATIONS:
BRICK / STONE: 75 %
SIDING: 25%

B A201/B NORTH ELEVATION

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

MATERIAL CALCULATION

ALL WEST FACING ELEVATIONS:
BRICK / STONE: 91 %
SIDING: 9%

A A201/A WEST ELEVATION

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

1 EXTERIOR WALL MATERIAL CALCULATIONS - 80% BRICK EXTERIOR REQUIRED

REGISTERED ARCHITECT
WILLIAM C. PECK
18501
STATE OF TEXAS
05-15-09

These plans are intended to provide the basic construction information necessary to substantially complete this structure. These construction documents must be verified and checked by the builder or person in authority of this project. Any discrepancy, error, and/ or omissions, if any, are to be brought to the attention of the Designer prior to any construction or purchases being made. It is recommended that the owner or builder obtain complete engineering services for: foundation, HVAC, and structural, prior to construction of any kind. NOTE: All Federal, state, and Local codes, ordinances, and restrictions take precedence over any part of these construction documents which may conflict with same, and must be strictly obeyed and followed before and during construction.

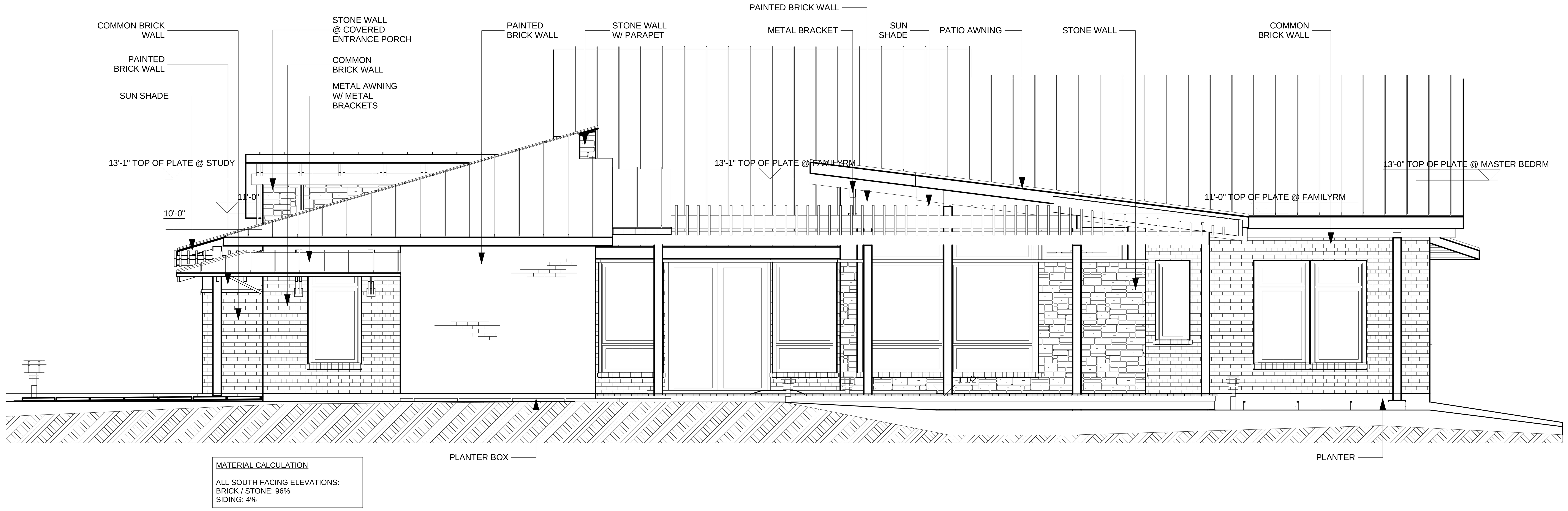
937 TIMBER CREEK DR.,
LEWISVILLE, TEXAS.

WILLIAM PECK &
ASSOCIATES INC.
ARCHITECTS
Lewisville, Tx (972) 221-1424

ELEVATIONS

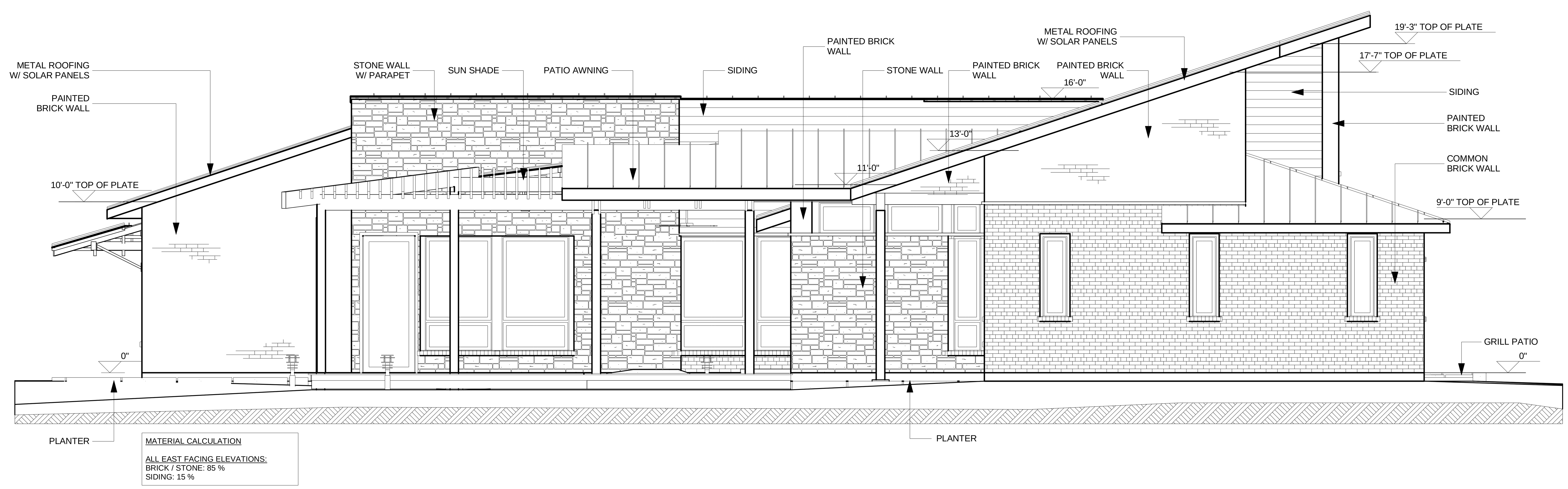
REVISIONS
DATE
1 05-15-09

Date: 04-29-09
Scale:
Drawn:
Job:
Sheet Number:
A-201
SHEET 10 OF 26



B A202/B SOUTH ELEVATION

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



A A202/A EAST ELEVATION

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

1 EXTERIOR WALL MATERIAL CALCULATIONS - 80% BRICK EXTERIOR REQUIRED

REGISTERED ARCHITECT WILLIAM C. PECK 18501 STATE OF TEXAS

05-15-09

These plans are intended to provide the basic construction information necessary to substantially complete this structure. These construction documents must be verified and checked by the builder or person in authority of this project. Any discrepancy, error, and/or omissions, if any, are to be brought to the attention of the Designer prior to any construction or purchases being made. It is recommended that the owner or builder obtain complete engineering services for foundation, HVAC, and structural prior to construction of any kind. NOTE: All Federal, state, and Local codes, ordinances, and restrictions take precedence over any part of these construction documents which may conflict with same, and must be strictly obeyed and followed before and during construction.

937 TIMBER CREEK DR., LEWISVILLE, TEXAS.

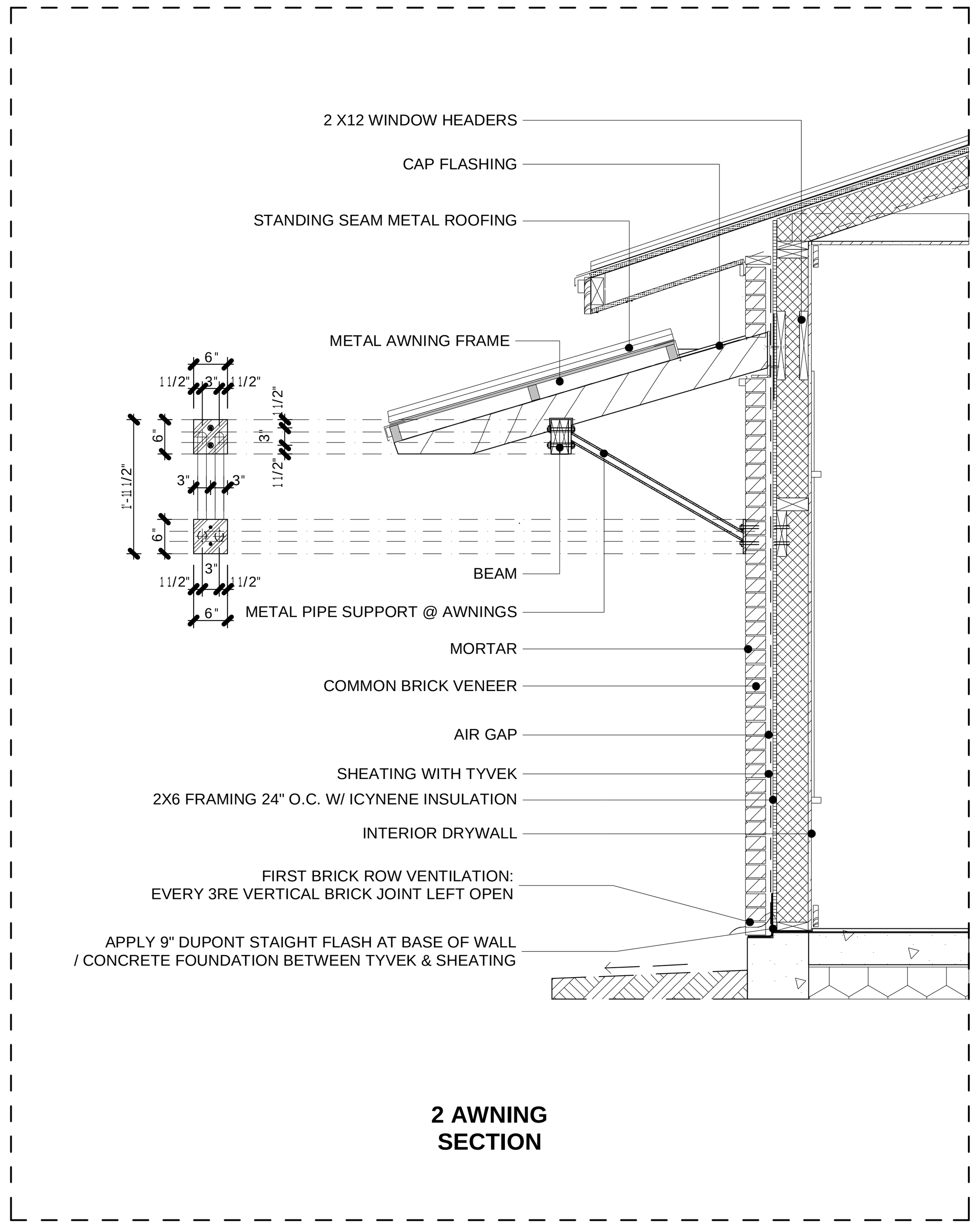
WILLIAM PECK & ASSOCIATES INC.
ARCHITECTS
Lewisville, Tx
(972) 221-1424

ELEVATIONS 2

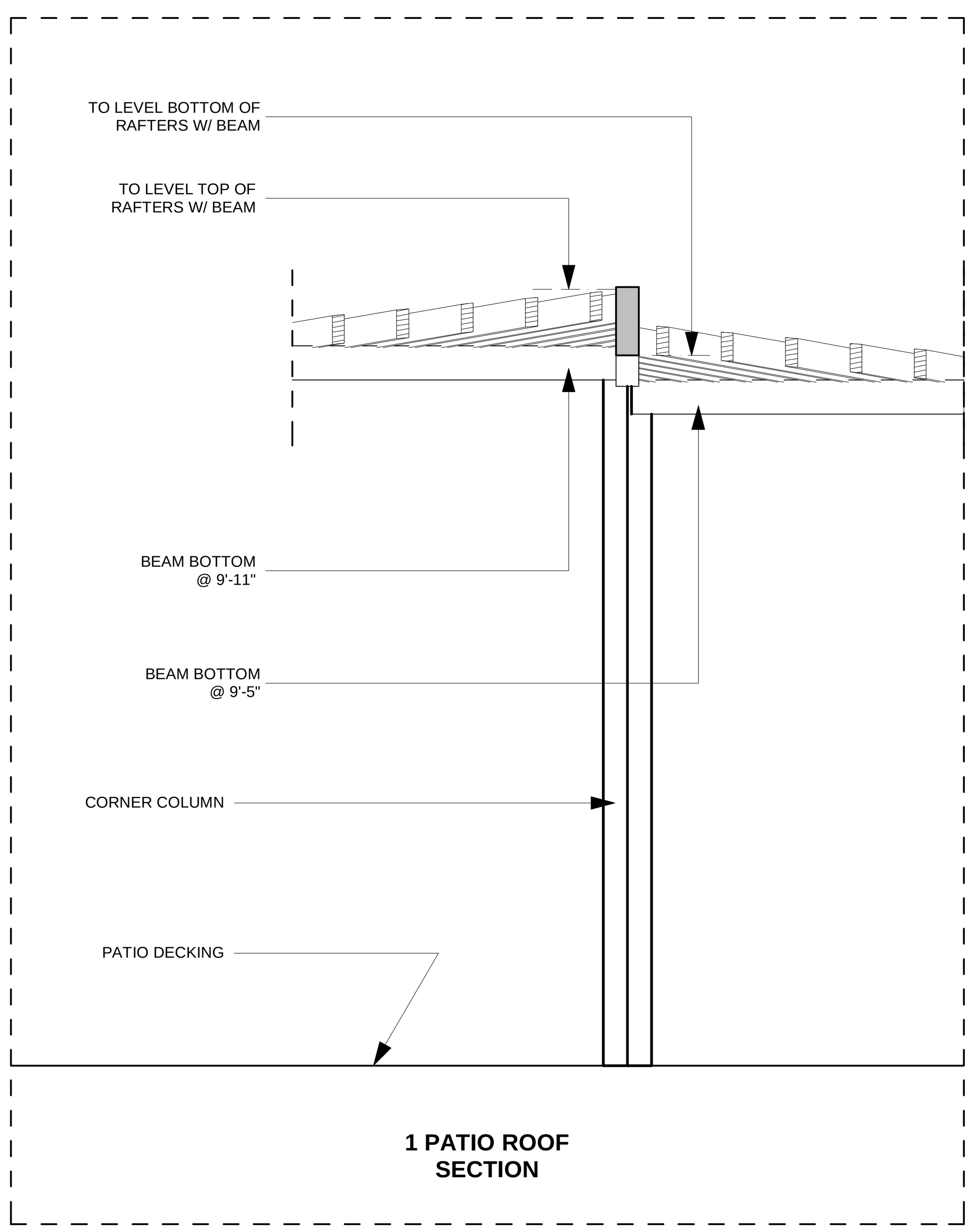
REVISIONS	
DATE	
1	05-15-09

Date:	04-29-09
Scale:	
Drawn:	
Job:	
Sheet Number:	A-202

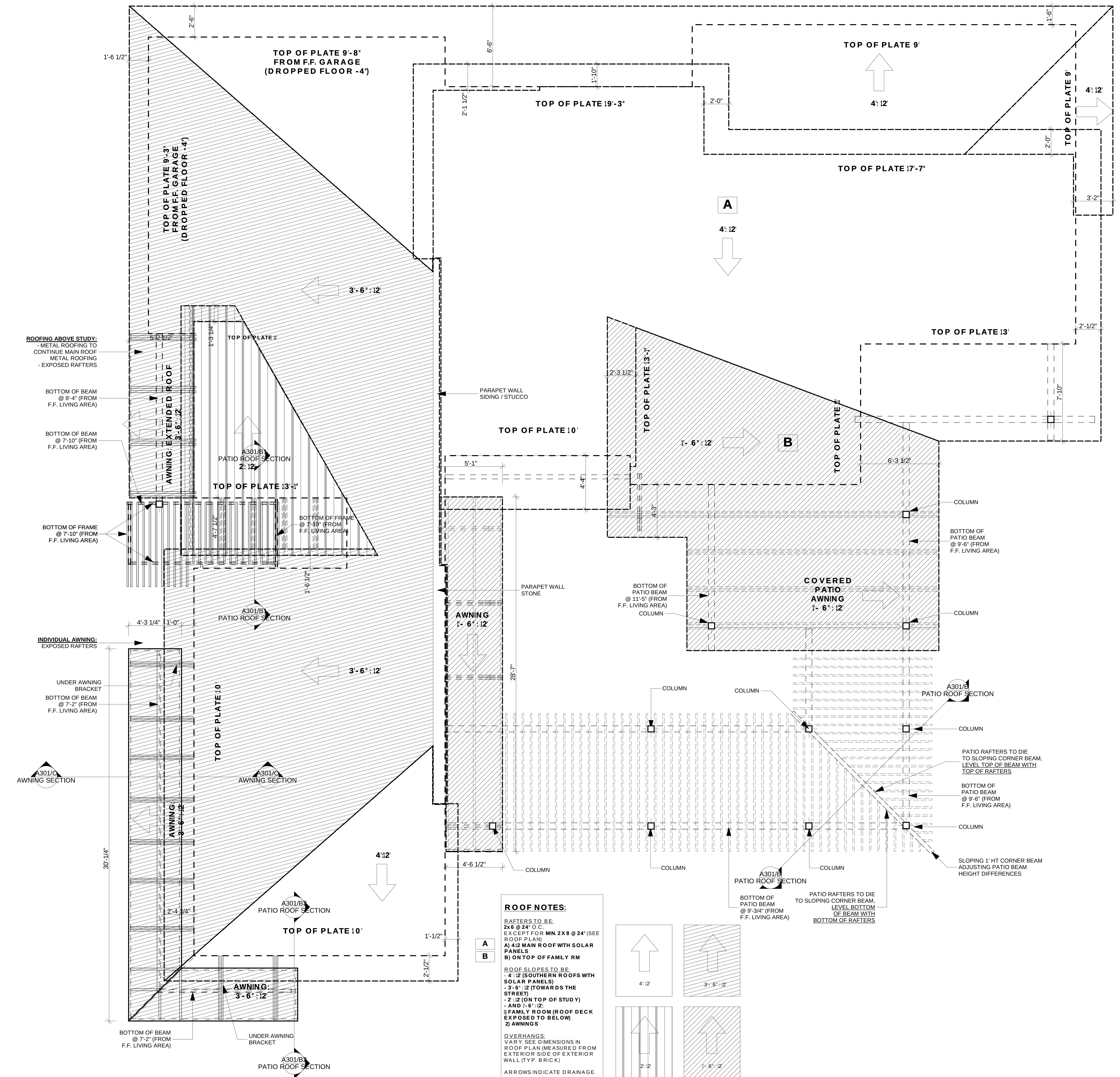
SHEET 11 OF 26



C A301/C AWNING SECTION
SCALE: 1/2" = 1'-0"



B A301/B PATIO AWNING SECTION
SCALE: 1/2" = 1'-0"



A ROOF PLAN
SCALE: 1/4" = 1'-0"

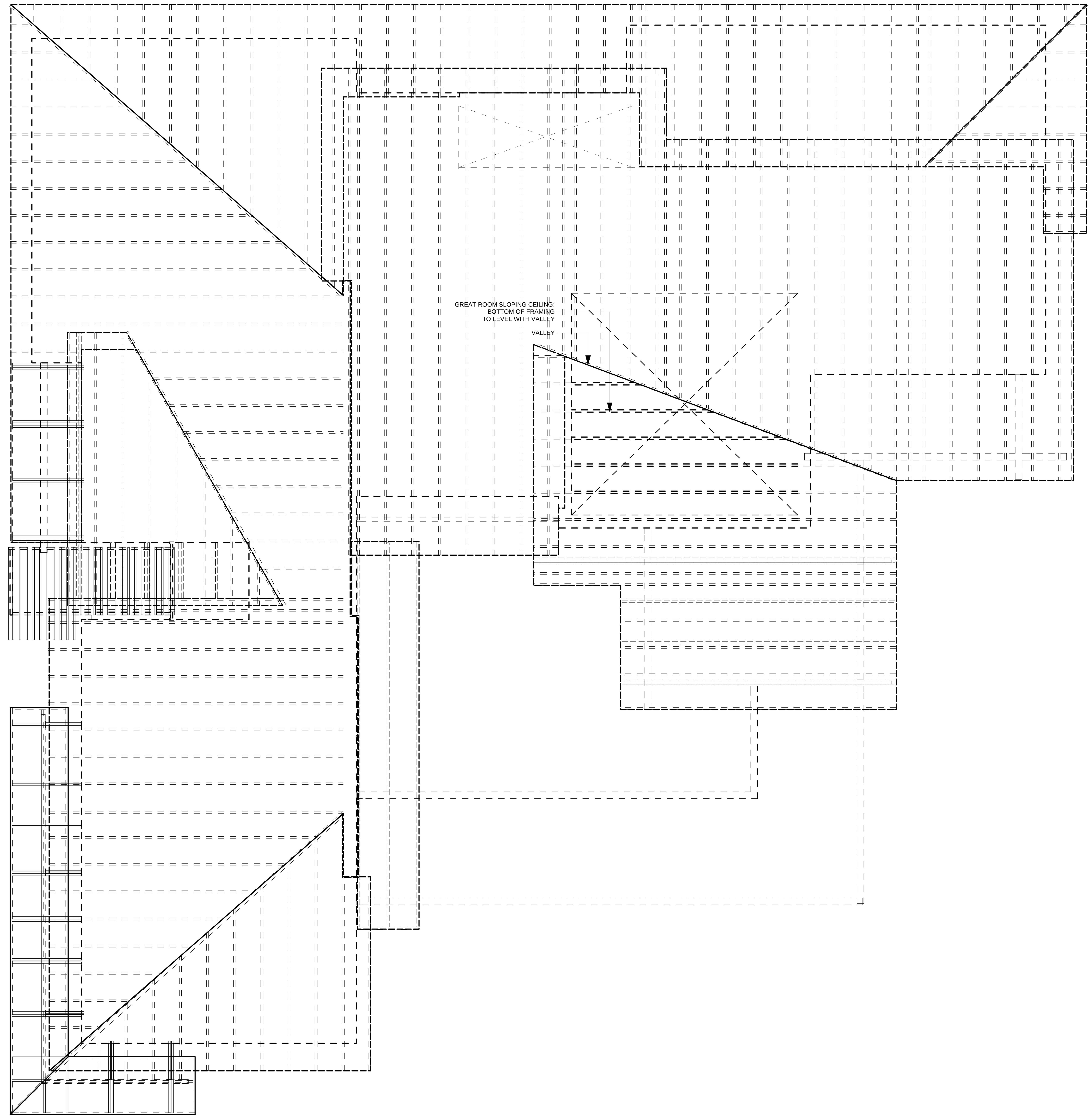
937 TIMBER CREEK DR.,
LEWISVILLE, TEXAS.

WILLIAM PECK &
ASSOCIATES INC.
ARCHITECTS
Lewisville, Tx
(972) 221-1424

ROOF PLAN & AWNING DETAILS

REVISIONS
DATE
1 05-15-09

Date: 04-29-09
Scale:
Drawn:
Job:
Sheet Number:
A-301
SHEET 13 OF 26



A ROOF FRAMING PLAN
SCALE: 1/4" = 1'-0"

REGISTERED ARCHITECT
WILLIAM C. PECK
18501
STATE OF TEXAS
05-15-09

These plans are intended to provide the basic construction information necessary to substantially complete this structure. These construction documents must be verified and checked by the builder or person in authority of this project. Any discrepancy, error, and/ or omissions, if any, are to be brought to the attention of the Designer prior to any construction or purchases being made. It is recommended that the owner or builder obtain complete engineering services for: foundation, HVAC, and structural, prior to construction of any kind.
NOTE: All Federal, state, and Local codes, ordinances, and restrictions take precedence over any part of these construction documents which may conflict with same, and must be strictly obeyed and followed before and during construction.

937 TIMBER CREEK DR.,
LEWISVILLE, TEXAS.

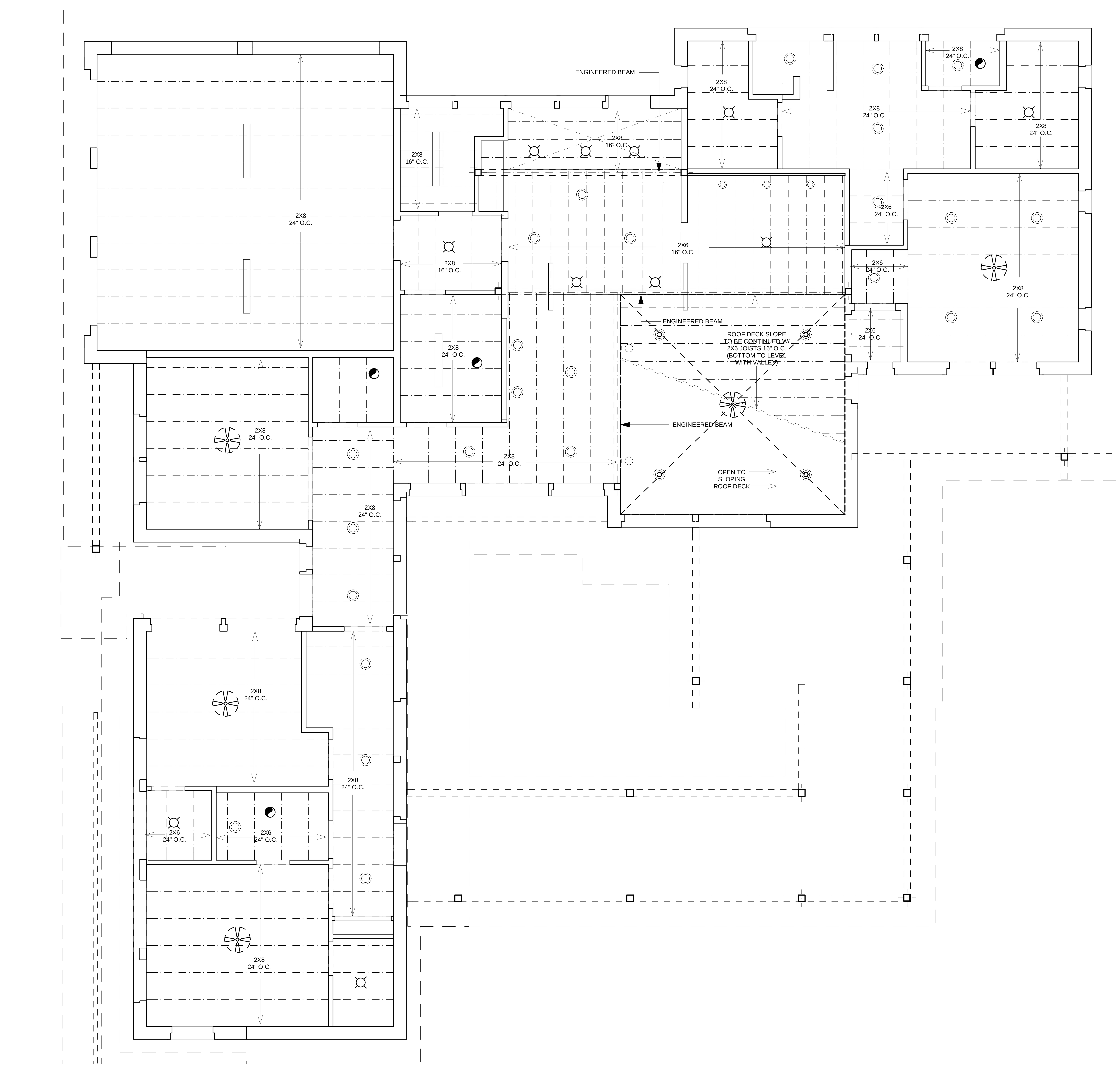
WILLIAM PECK &
ASSOCIATES INC.
ARCHITECTS
Lewisville, Tx
(972) 221-1424

ROOF FRAMING

REVISIONS	
DATE	
1	05-15-09

Date: 04-29-09
Scale:
Drawn:
Job:

Sheet Number:
A-302
SHEET 14 OF 26



A 1st FLOOR RCP

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

REGISTERED ARCHITECT
WILLIAM C. PECK
18501
STATE OF TEXAS
05-15-09

These plans are intended to provide the basic construction information necessary to substantially complete this structure. These construction documents must be verified and checked by the builder or person in authority of this project. Any discrepancy, error, and/ or omissions, if any, are to be brought to the attention of the Designer prior to any construction or purchases being made. It is recommended that the owner or builder obtain complete engineering services for: foundation, HVAC, and structural, prior to construction of any kind.
NOTE: All Federal, state, and Local codes, ordinances, and restrictions take precedence over any part of these construction documents which may conflict with same, and must be strictly obeyed and followed before and during construction.

937 TIMBER CREEK DR.,
LEWISVILLE, TEXAS.

WILLIAM PECK &
ASSOCIATES INC.
ARCHITECTS
Lewisville, Tx
(972) 221-1424

CEILING PLANS

REVISIONS
DATE
1 05-15-09

Date: 04-29-09

Scale:

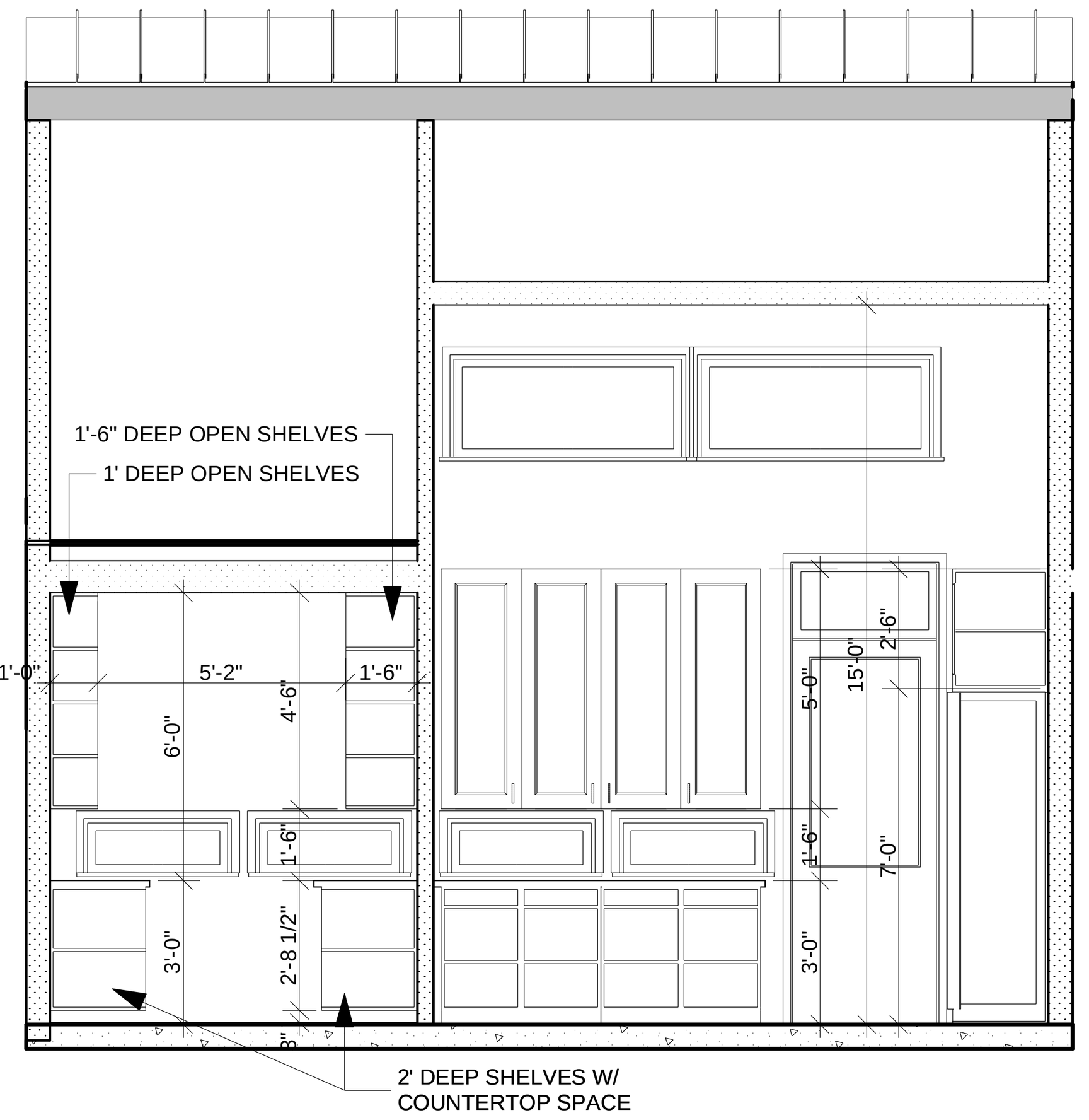
Drawn:

Job:

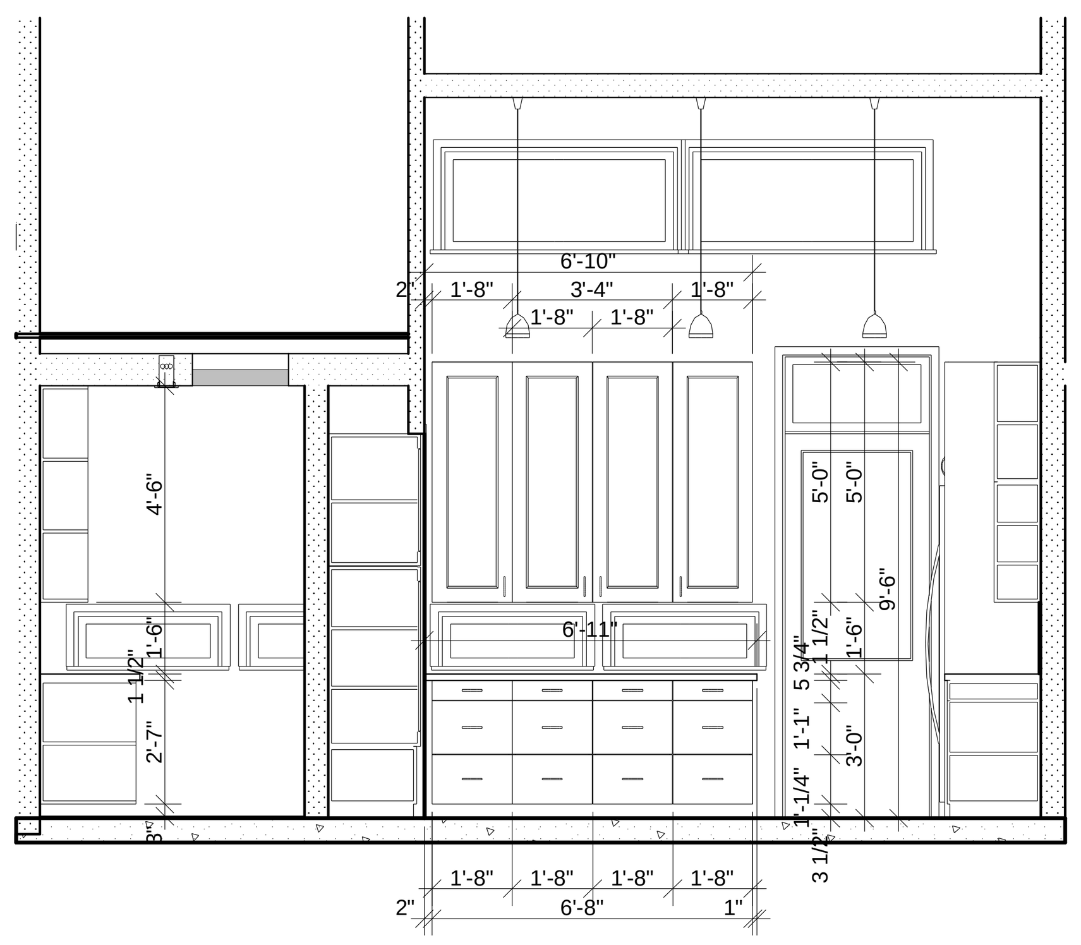
Sheet Number:

A-303

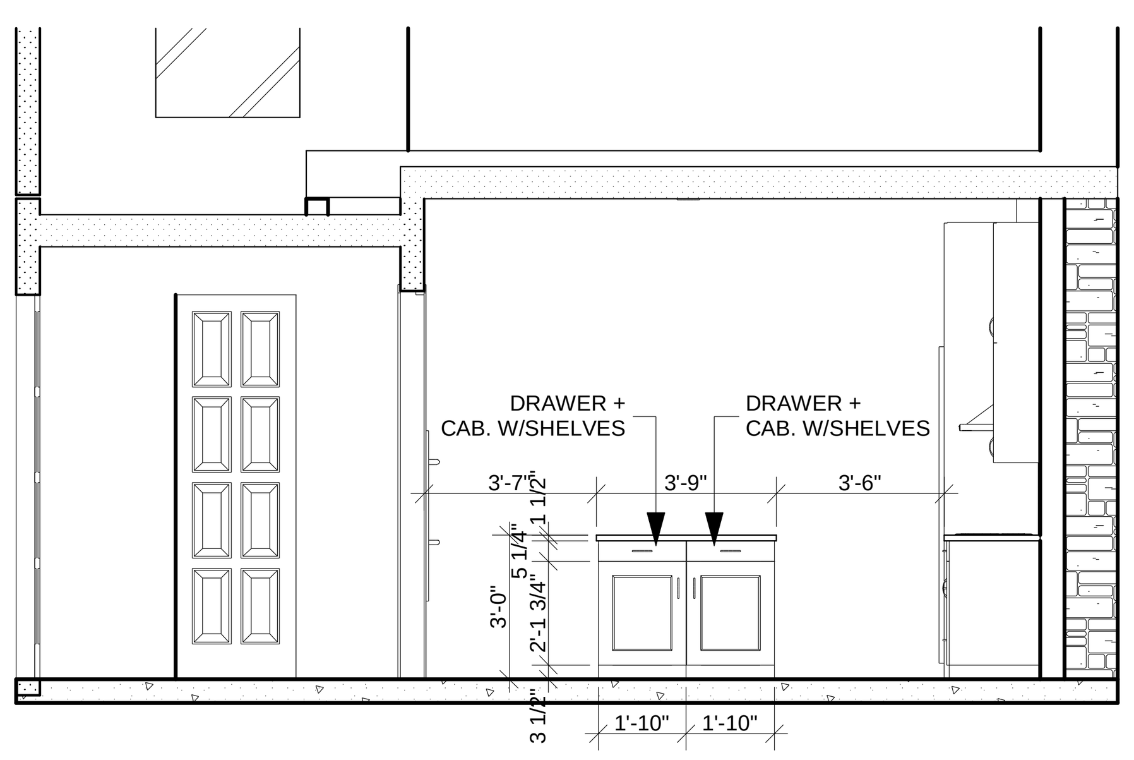
SHEET 15 OF 26



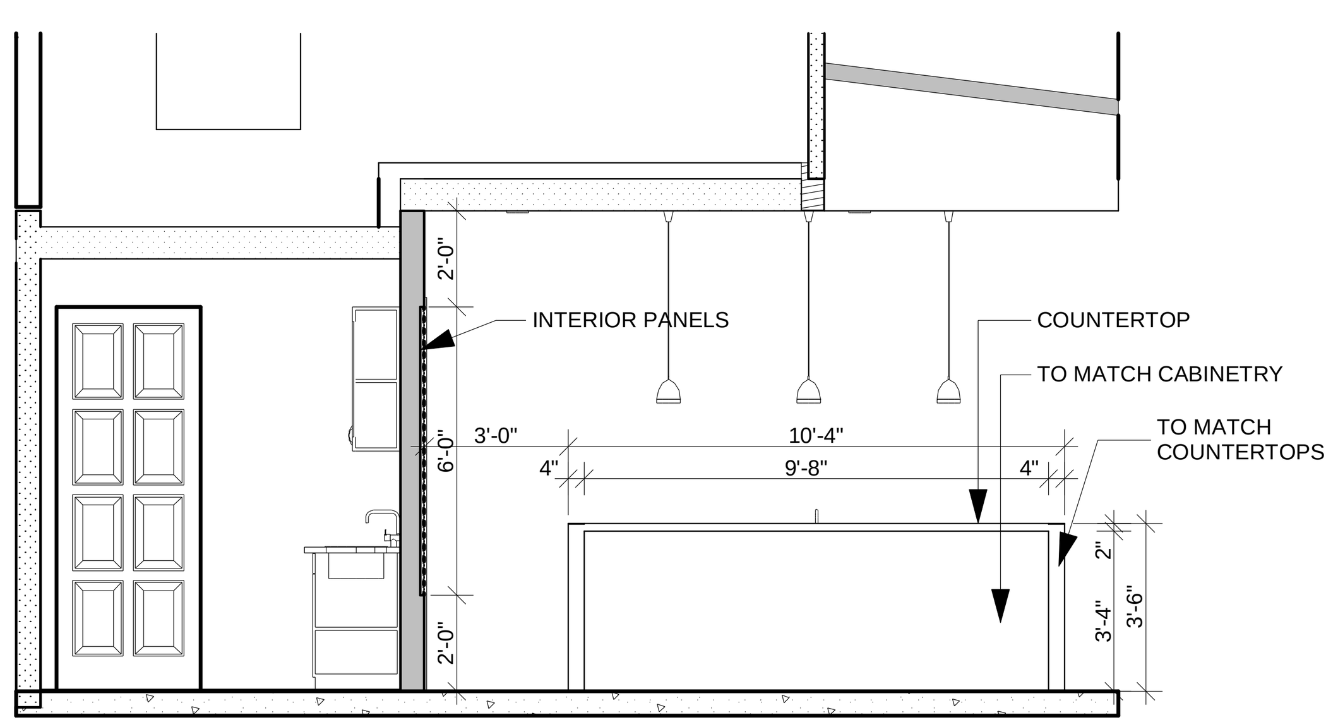
H A401/H PANTRY & KITCHEN WINDOW W.
SCALE: 1/4" = 1'-0"



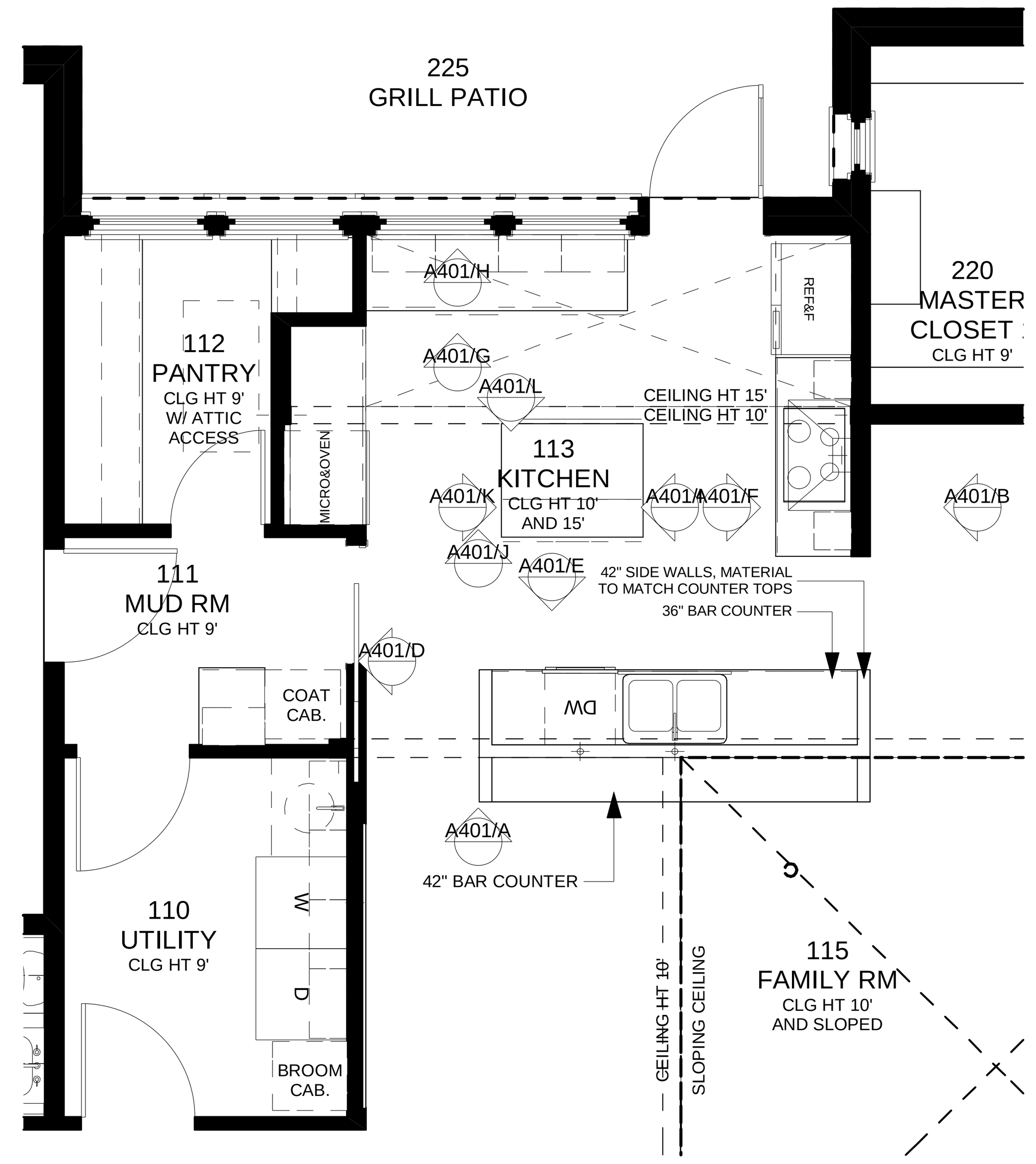
G A401/G KITCHEN WINDOW WALL
SCALE: 1/4" = 1'-0"



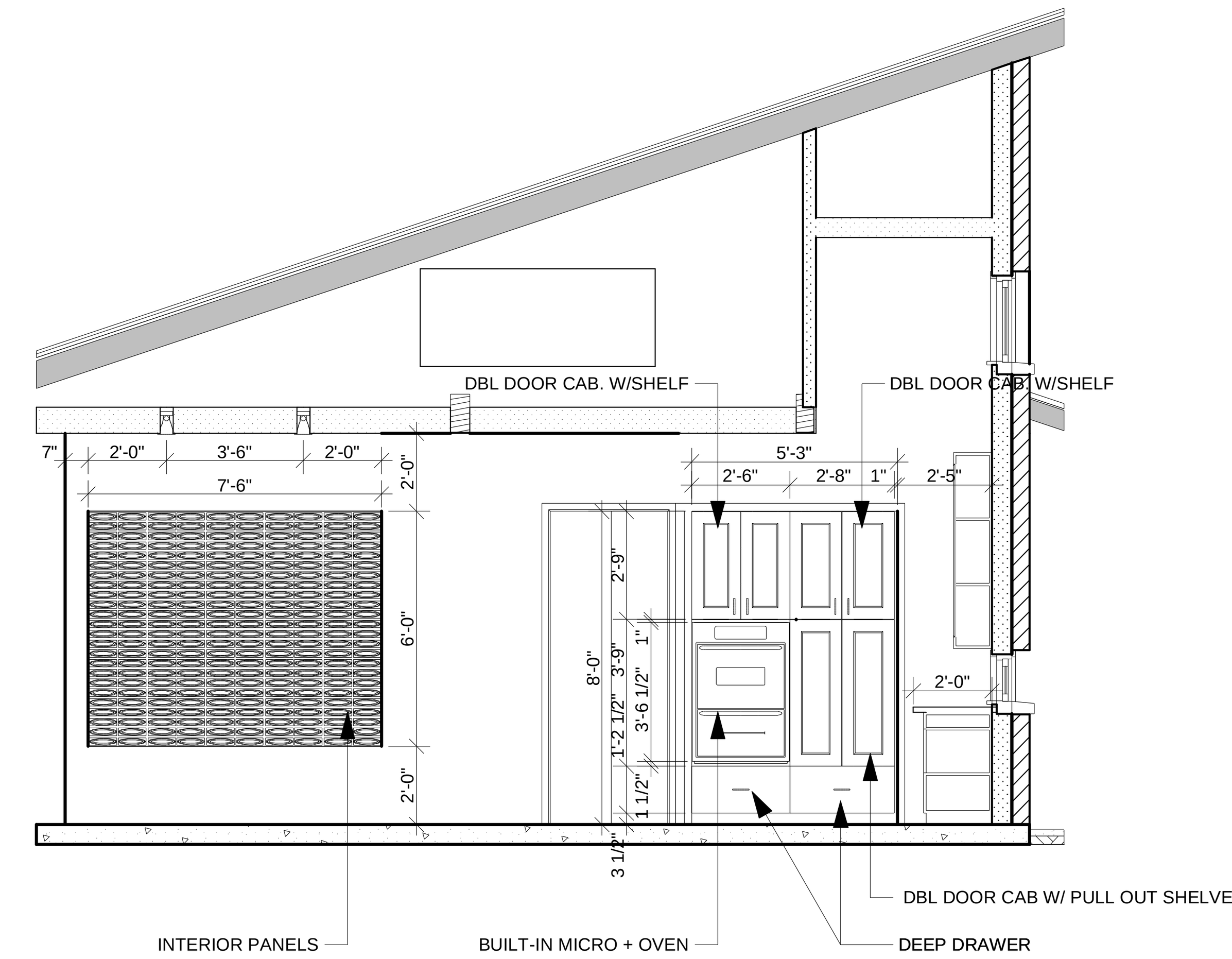
J A401/J CENTER ISLAND
SCALE: 1/4" = 1'-0"



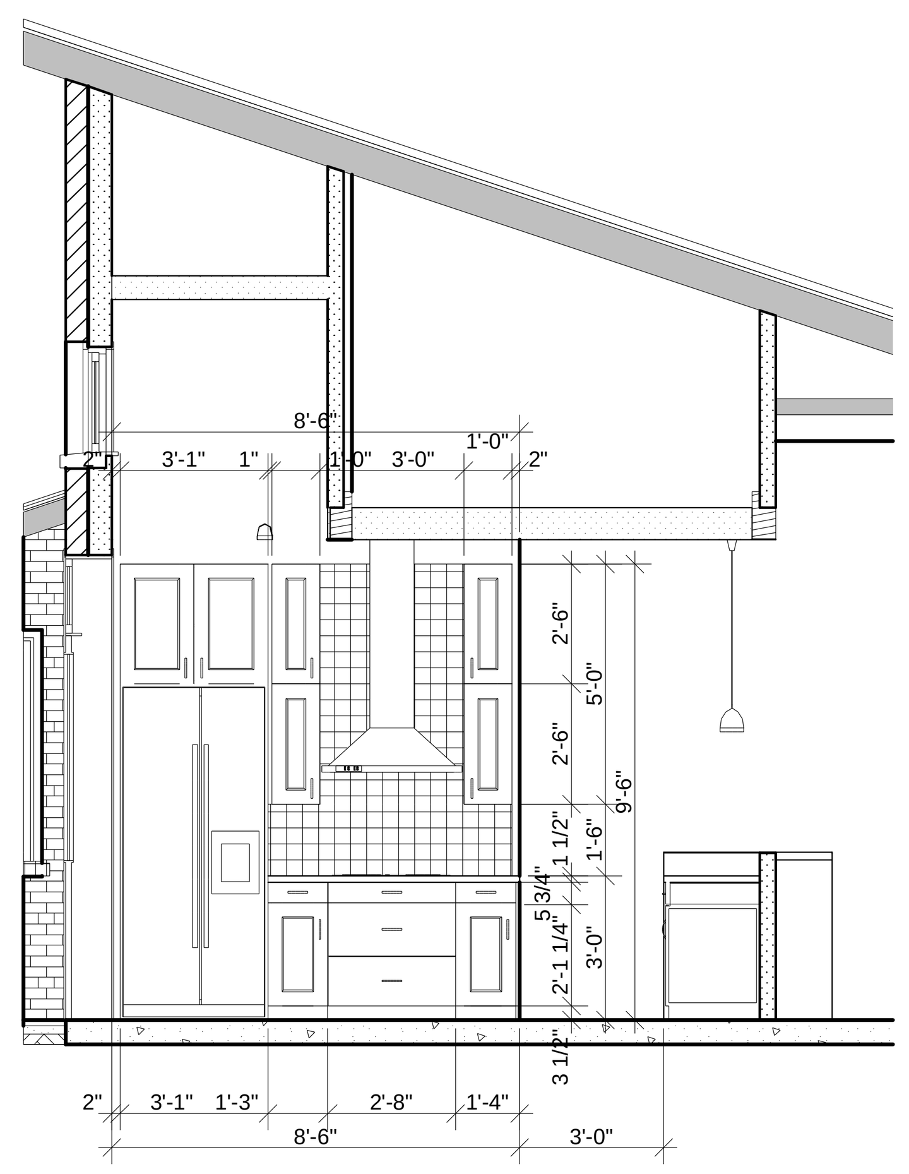
A A401/A KITCHEN ISLAND
SCALE: 1/4" = 1'-0"



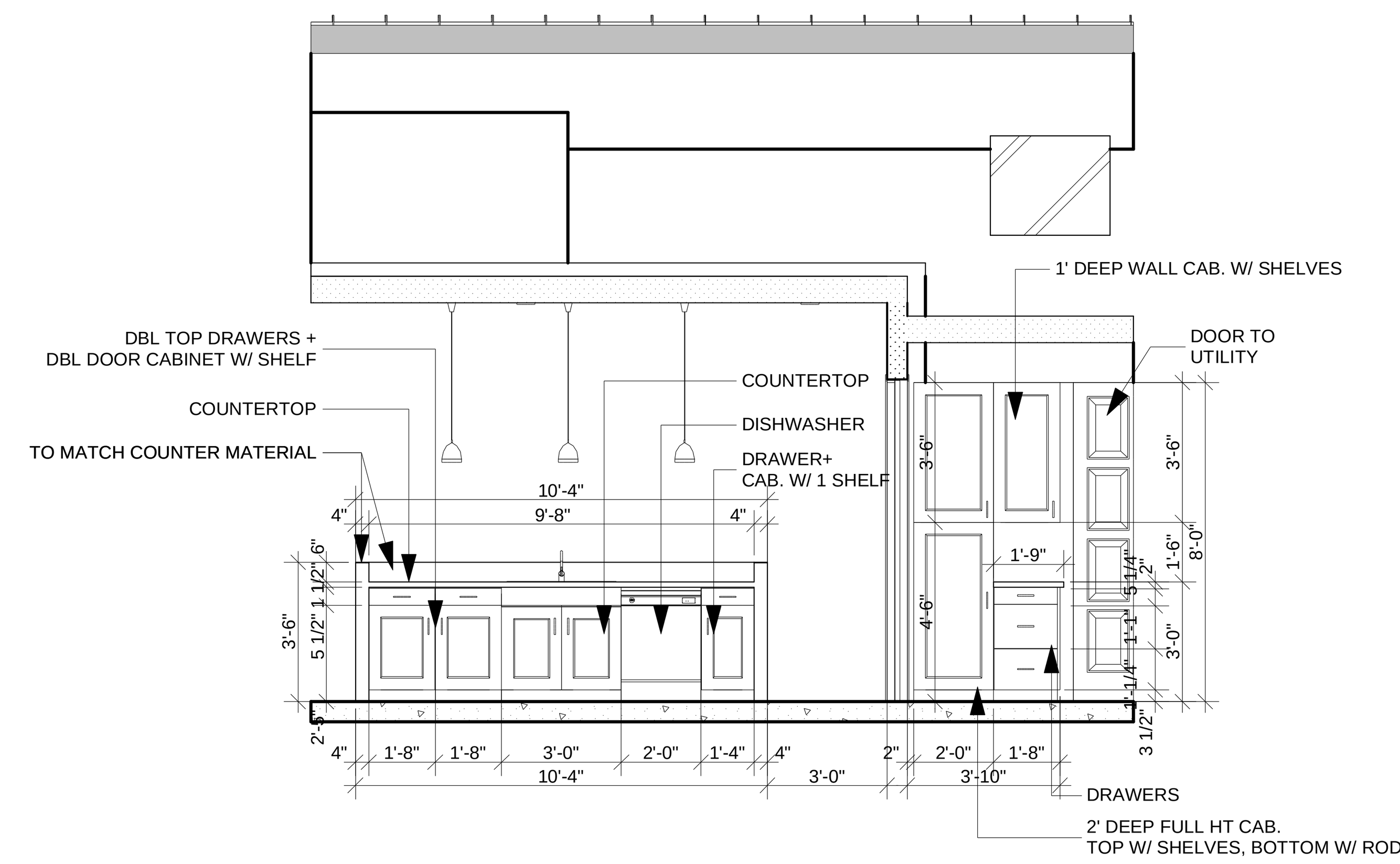
X INTERIOR ELEV. LAYOUT
SCALE: 1/4" = 1'-0"



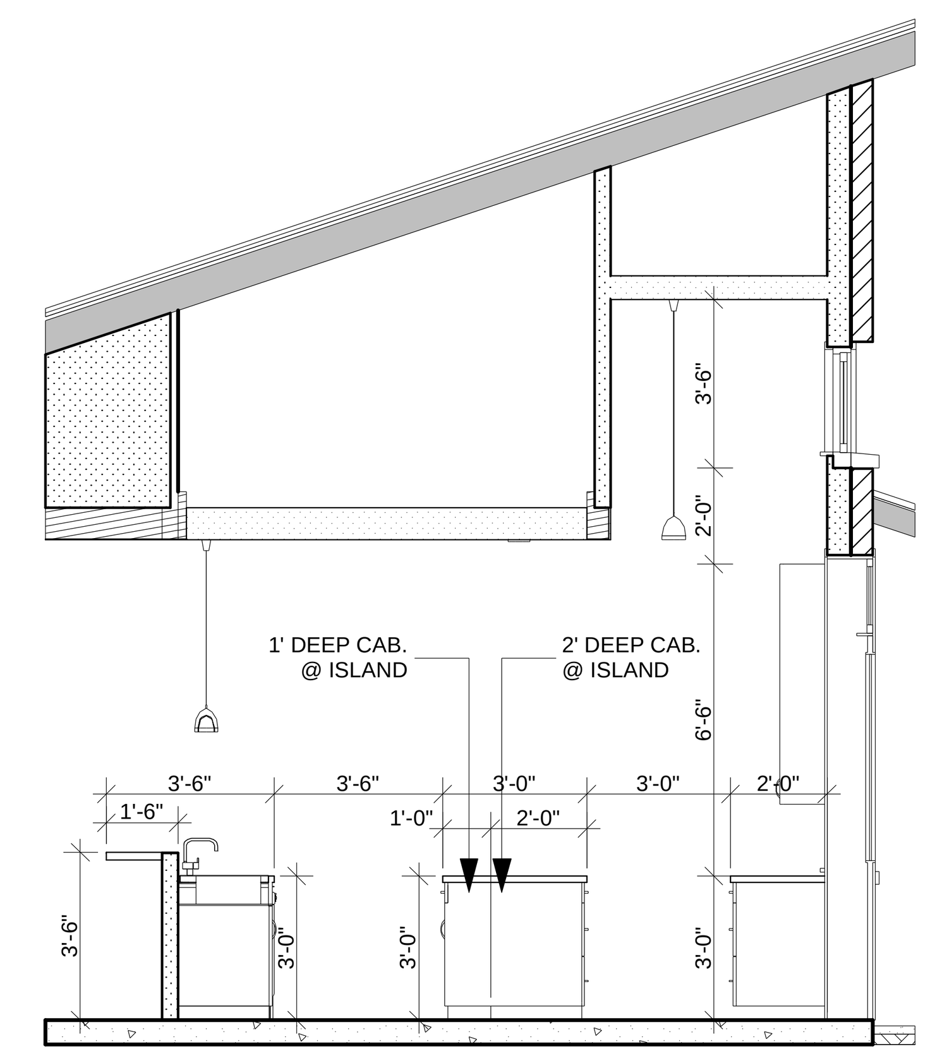
D A401/D KITCHEN VS PANTRY
SCALE: 1/4" = 1'-0"



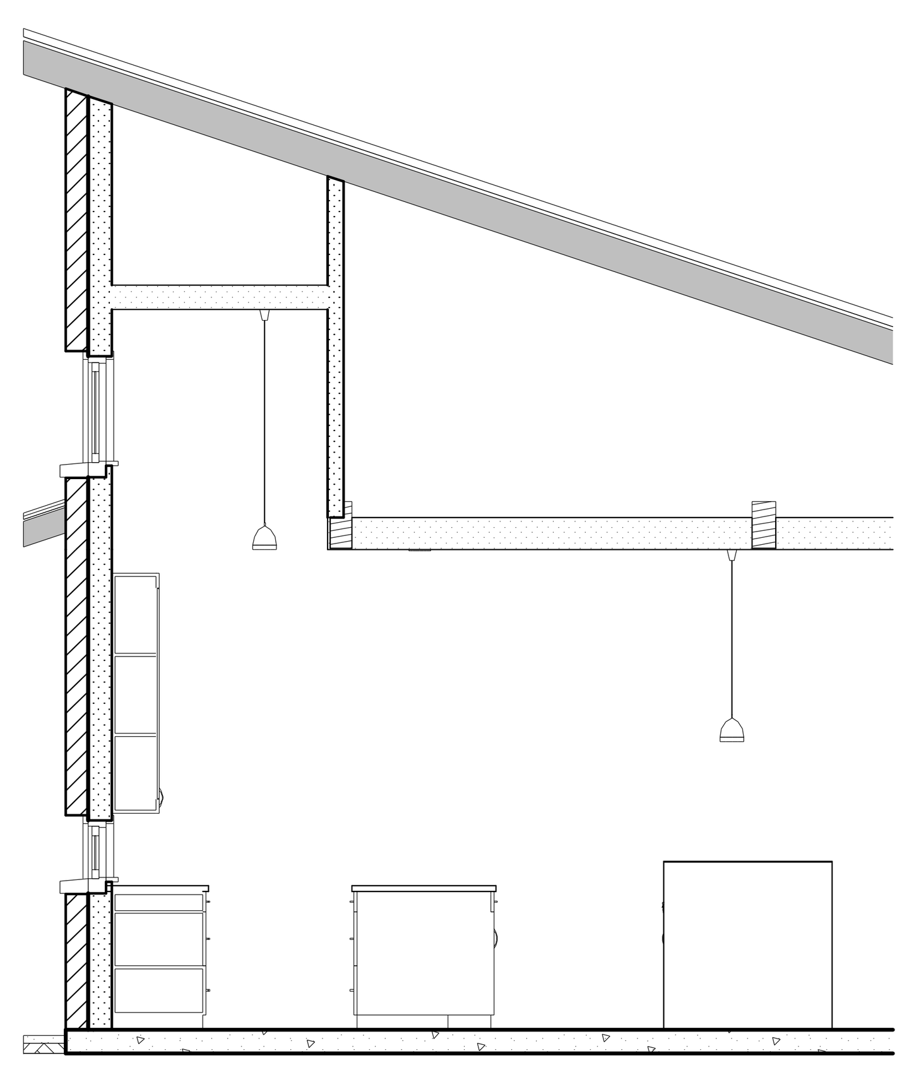
F A401/F KITCHEN VS DINING RM
SCALE: 1/4" = 1'-0"



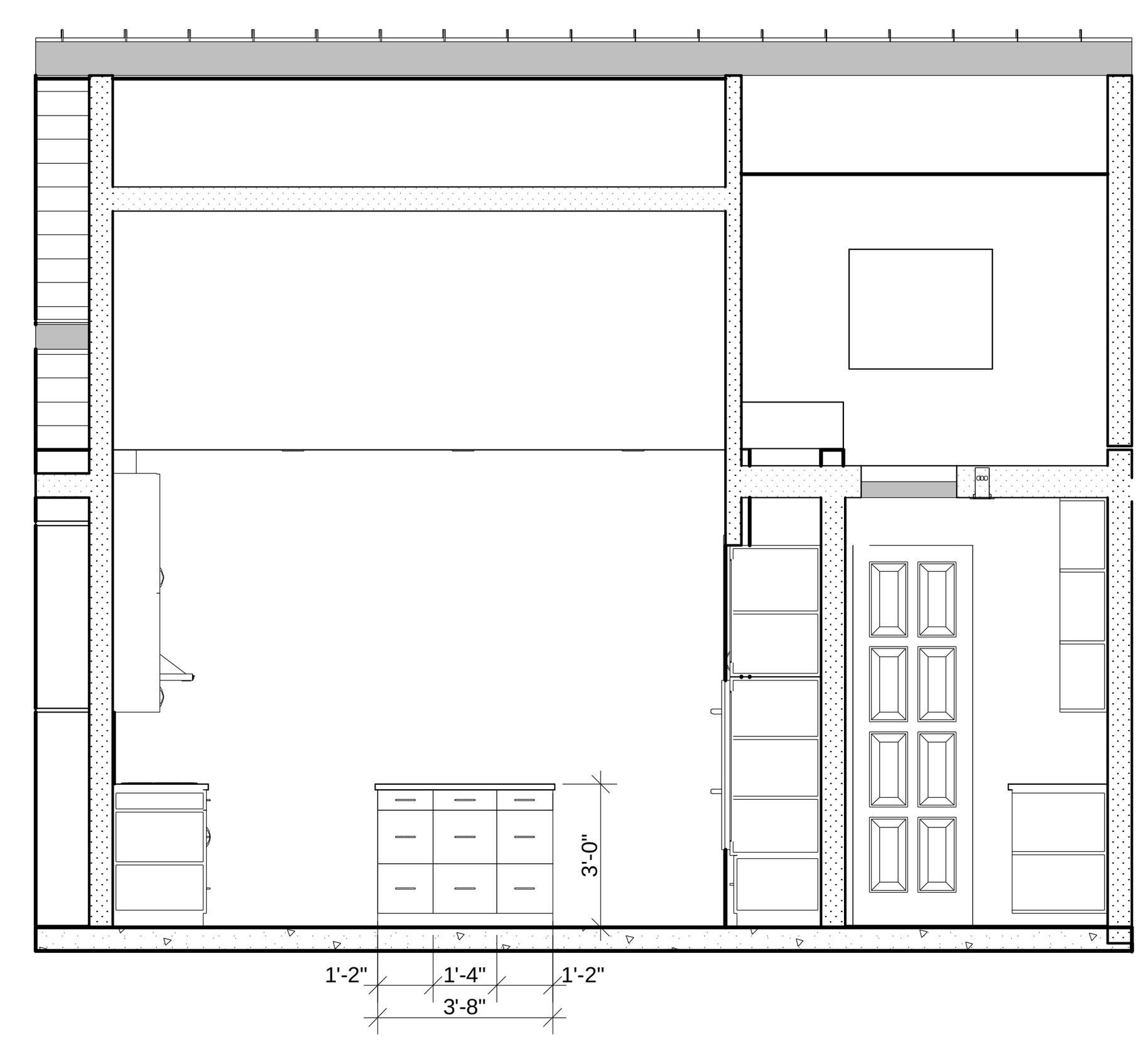
E A401/E KITCHEN ISLAND FRONT
SCALE: 1/4" = 1'-0"



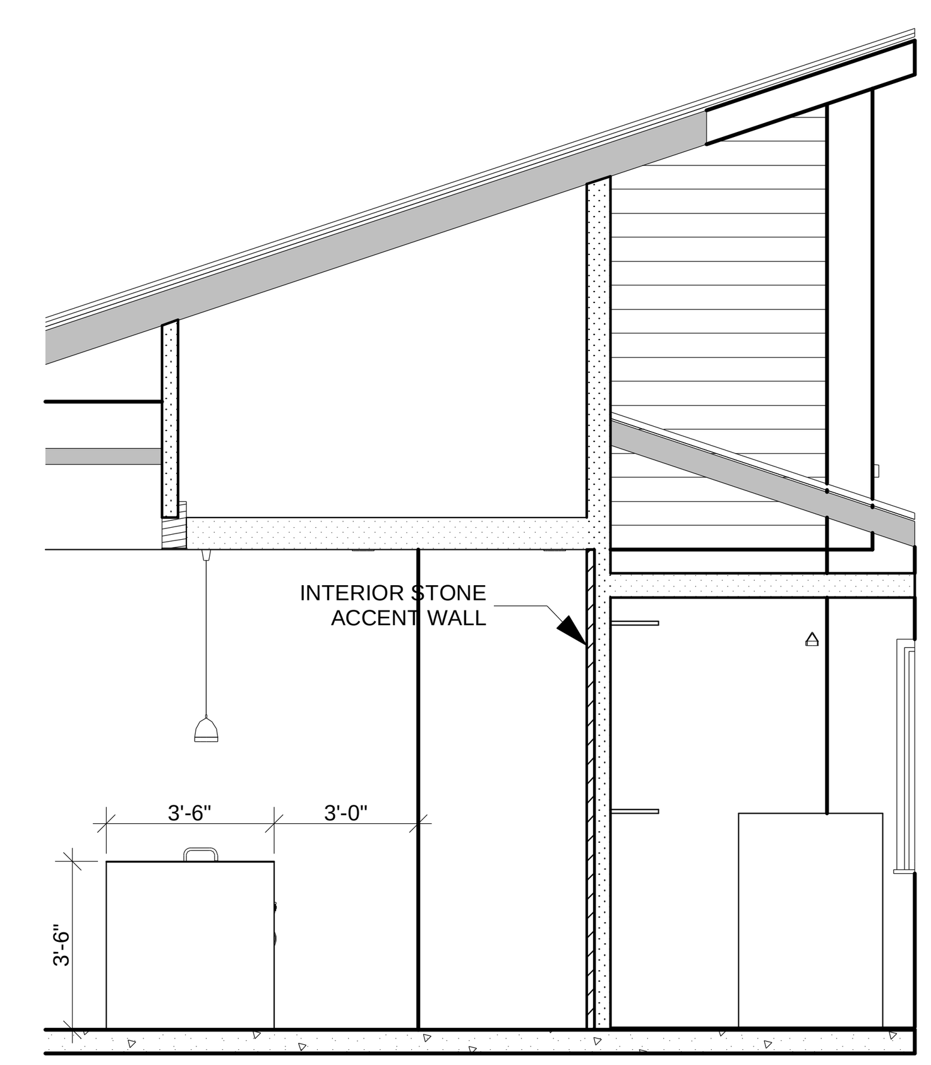
I A401/I ISLAND, MID-ISLAND AND W. WALL
SCALE: 1/4" = 1'-0"



K A401/K SECTION
SCALE: 1/4" = 1'-0"



L A401/L MID-ISLAND TOWARDS WINDOWS
SCALE: 1/4" = 1'-0"



B A401/B KITCHEN ISLAND SIDE
SCALE: 1/4" = 1'-0"

05-15-09

937 TIMBER CREEK DR.,
LEWISVILLE, TEXAS.

WILLIAM PECK &
ASSOCIATES INC.
ARCHITECTS
Lewisville, Tx
(972) 221-1424

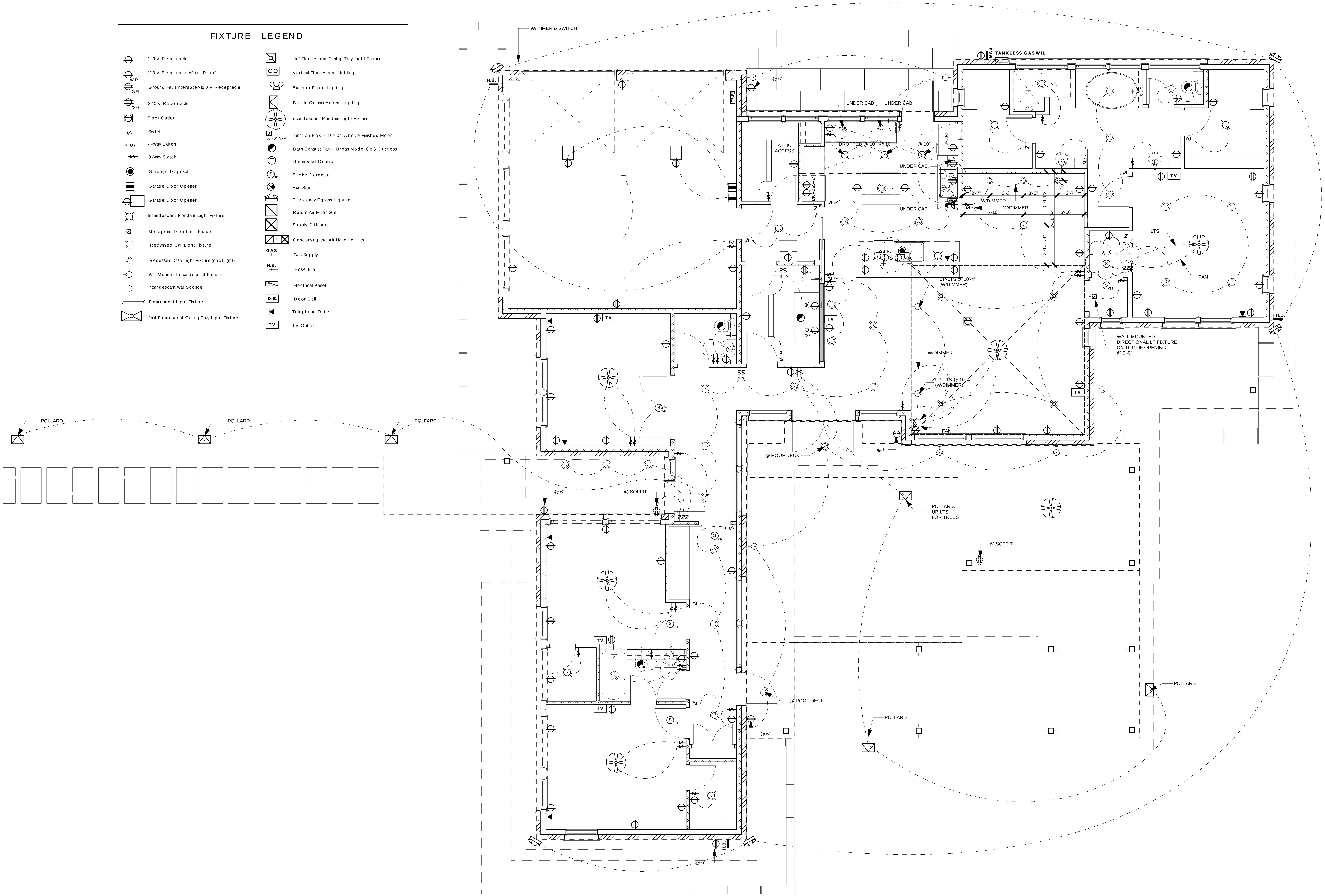
REVISIONS
DATE
1 05-15-09

INTERIOR DETAILS

Date: 04-29-09
Scale:
Drawn:
Job:
Sheet Number:
A-401
SHEET 16 OF 26

FIXTURE LEGEND

- 120 V Receptacle
- 120 V Receptacle Water Proof (W.P.)
- Ground Fault Interupter-120 V Receptacle (GFI)
- 220 V Receptacle
- Floor Outlet
- Switch
- 4-Way Switch
- 3-Way Switch
- Garbage Disposal
- Garage Door Opener
- Garage Door Opener
- Incandescent Pendant Light Fixture
- Monopoint Directional Fixture
- Recessed Can Light Fixture
- Recessed Can Light Fixture (spot light)
- Wall Mounted Incandescant Fixture
- Incandescant Wall Sconce
- Flourescent Light Fixture
- 2x4 Flourescent Ceiling Tray Light Fixture
- 2x2 Flourescent Ceiling Tray Light Fixture
- Vertical Flourescent Lighting
- Exterior Flood Lighting
- Built-in Column Accent Lighting
- Incandescent Pendant Light Fixture
- Junction Box - 10'-0" Above Finished Floor (10'-0" AFF)
- Bath Exhaust Fan - Broan Model 686 Ductless
- Thermostat Control
- Smoke Detector
- Exit Sign
- Emergency Egress Lighting
- Return Air Filter Grill
- Supply Diffuser
- Condensing and Air Handling Units
- Gas Supply (GAS)
- Hose Bib (H.B.)
- Electrical Panel
- Door Bell (D.B.)
- Telephone Outlet
- TV Outlet (TV)



A ELECTRICAL FIRST FLOOR

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

REGISTERED ARCHITECT WILLIAM C. PECK 18501 STATE OF TEXAS

05-15-09

These plans are intended to provide the basic construction information necessary to substantially complete this structure. These construction documents must be verified and checked by the builder or person in authority of this project. Any discrepancy, error, and/ or omissions, if any, are to be brought to the attention of the Designer prior to any construction or purchases being made. It is recommended that the owner or builder obtain complete engineering services for: foundation, HVAC, and structural, prior to construction of any kind. NOTE: All Federal, state, and Local codes, ordinances, and restrictions take precedence over any part of these construction documents which may conflict with same, and must be strictly obeyed and followed before and during construction.

937 TIMBER CREEK DR., LEWISVILLE, TEXAS.

WILLIAM PECK & ASSOCIATES INC.
ARCHITECTS
Lewisville, Tx
(972) 221-1424

ELECTRICAL/1

REVISIONS

DATE

1 05-15-09

Date: 04-29-09

Scale:

Drawn:

Job:

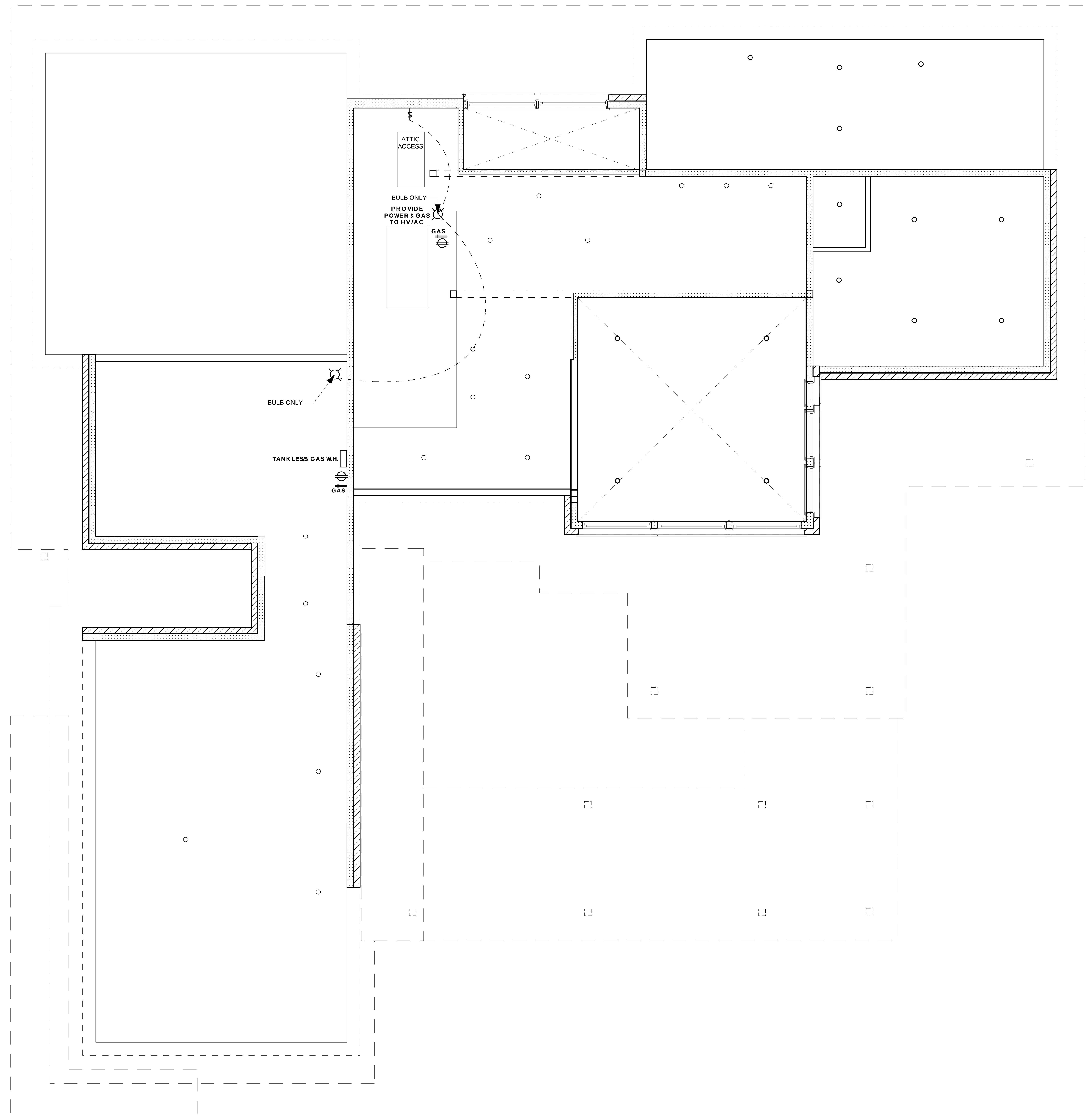
Sheet Number:

E-01

SHEET 18 OF 26

FIXTURE LEGEND

120 V Receptacle	2x2 Flourescent Ceiling Tray Light Fixture
120 V Receptacle Water Proof (W.P.)	Vertical Flourescent Lighting
Ground Fault Interupter-120 V Receptacle (GFI)	Exterior Flood Lighting
220 V Receptacle (220)	Built-In Column Accent Lighting
Floor Outlet	Incandescent Pendant Light Fixture
Switch	Junction Box - 10'-0" Above Finished Floor (10'-0" AFF)
4-Way Switch	Bath Exhaust Fan - Broan Model 686 Ductless
3-Way Switch	Thermostat Control
Garbage Disposal	Smoke Detector
Garage Door Opener	Exit Sign
Garage Door Opener	Emergency Egress Lighting
Incandescent Pendant Light Fixture	Return Air Filter Grill
Monopoint Directional Fixture	Supply Diffuser
Recessed Can Light Fixture	Condensing and Air Handling Units
Recessed Can Light Fixture (spot light)	Gas Supply (GAS)
Wall Mounted Incandescant Fixture	Hose Bib (H.B.)
Incandescant Wall Sconce	Electrical Panel
Flourescent Light Fixture	Door Bell (D.B.)
2x4 Flourescent Ceiling Tray Light Fixture	Telephone Outlet
	TV Outlet (TV)



A ELECTRICAL ATTIC

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

REGISTERED ARCHITECT WILLIAM C. PECK 18501 STATE OF TEXAS

05-15-09

937 TIMBER CREEK DR.,
LEWISVILLE, TEXAS.

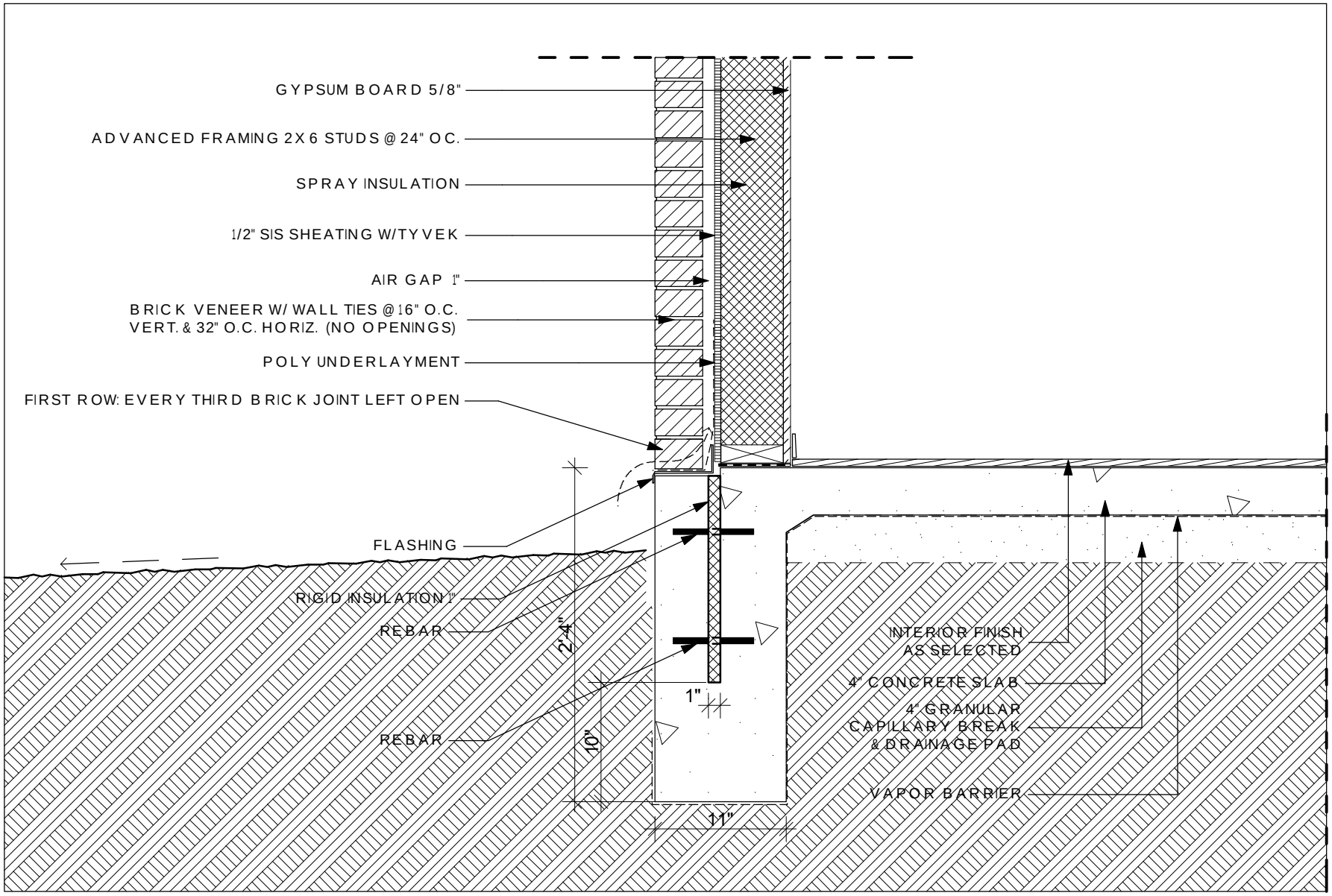
WILLIAM PECK &
ASSOCIATES INC.
ARCHITECTS
Lewisville, Tx (972) 221-1424

ELECTRICAL/2

REVISIONS

DATE
1 05-15-09

Date: 04-29-09
Scale:
Drawn:
Job:
Sheet Number:
E-02
SHEET 19 OF 26


GYPSUM BOARD 5/8"
ADVANCED FRAMING 2X6 STUDS @ 24" OC.
SPRAY INSULATION
1/2" SIS SHEATING W/TYVEK
AIR GAP 1"
BRICK VENEER W/ WALL TIES @16" O.C.
VERT. & 32" O.C. HORIZ. (NO OPENINGS)
POLY UNDERLAYMENT
FIRST ROW: EVERY THIRD BRICK JOINT LEFT OPEN
FLASHING
RIGID INSULATION 1"
REBAR
REBAR
2'-4"
10"
1"
11"
INTERIOR FINISH
AS SELECTED
4" CONCRETE SLAB
4" GRANULAR
CAPILLARY BREAK
& DRAINAGE PAD
VAPOR BARRIER

SCALE : 1" = 1'-0"

GENERAL NOTES

CAST IN PLACE CONCRETE

1. CAST–IN–PLACE CONCRETE SHALL CONFORM TO ACI 318–95.
2. REINFORCING STEEL SHALL BE DETAILED, FABRICATED, AND PLACED IN ACCORDANCE WITH ACI–315 DETAILING MANUAL.
3. CONCRETE SHALL BE NORMAL WEIGHT WITH A MINIMUM OF 3,000 PSI COMPRESSIVE STRENGTH AT 28 DAYS WITH A MINIMUM 5 SACKS PORTLAND CEMENT PER CUBIC YARD.
4. MILD STEEL REINFORCING BARS SHALL BE ASTM A615, GRADE 60.
5. PROVIDE ONE #5 BAR OR MATCHING SIZE CORNER BAR X 4'–0" LONG (2'–0" EACH LEG) FOR EACH HORIZONRTAL BAR AT CORNER IN GRADE BEAMS.
6. BARS CALLED FOR AS CONTINUOUS SHALL HAVE STAGGERED LAPS 40 BAR DIAMETERS (2'–0" MINIMUM).
7. LAP TOP REINFORCING IN GRADE BEAMS AT MID SPAN. LAP BOTTOM REINFORCING IN GRADE BEAMS AT PIERS.
8. PROVIDE STANDARD BEND IN ALL TOP BARS AT END SPANS OF GRADE BEAMS.
9. MINIMUM CONCRETE COVER OVER REINFORCING BARS SHALL BE:
   3" FOR CONCRETE CAST AGAINST SOIL.
   2" FOR CONCRETE EXPOSED TO WEATHER.
   1–1/2" FOR TOP AND SIDE OF GRADE BEAMS NOT EXPOSED TO WEATHER.

SITE PREPARATION NOTES

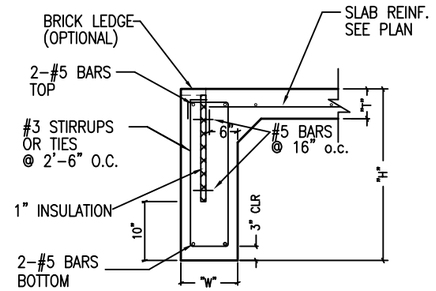
1. EXCAVATIONS SHALL CONFORM TO THE LINES AND GRADES SHOWN ON THE PLANS OR AS DIRECTED BY THE ENGINEER.
2. IT IS THE CONTRACTORS RESPONSIBILITY TO LOCATE EXISTING UTILITIES PRIOR TO EXCAVATION. CONTRACTOR SHALL EXERCISE CAUTION WHILE EXCAVATING TO AVOID DAMAGE TO UNDERGROUND UTILITIES. CONTRACTOR SHALL INFORM UTILITY OWNERS IN ADVANCE TO IDENTIFY, LOCATE, REROUTE OR MAKE OTHER ADJUSTMENTS IN ORDER FOR WORK TO PROCEED WITH MINIMUM DELAY.
3. ALL FOUNDATION EXCAVATIONS SHOULD BE PROPERLY MONITORED TO ENSURE THAT UNDESIRABLE (LOOSE) MATERIALS ARE REMOVED.
4. EXPOSED SOILS SHOULD BE PROTECTED AGAINST RAIN AND EXCESSIVE DRYING.
5. SELECT FILL MATERIAL WITH A PI BELOW 25 SHOULD BE COMPACTED TO A DRY DENSITY OF 95% STANDARD PROCTOR (ASTM D 698), WITH A MOISTURE CONTENT OF 2% (+/–) OPTIMUM.
6. CLAY SOILS WITH A PI EQUAL TO OR GREATER THAN 25 SHOULD BE COMPACTED TO A DRY DENSITY OF 95% STANDARD PROCTOR (ASTM D 698), WITH A MOISTURE CONTENT OF 0% TO 4% ABOVE OPTIMUM AT TIME OF PLACEMENT.
7. COMPACTION OF FILL SHOULD BE ACCOMPLISHED WITH A MAXIMUM OF 8" LOOSE LIFTS.
8. FIELD DENSITY AND MOISTURE CONTENT TESTS ARE RECOMMENDED TO ENSURE ADEQUATE COMPACTION.

CONSTRUCTION NOTES

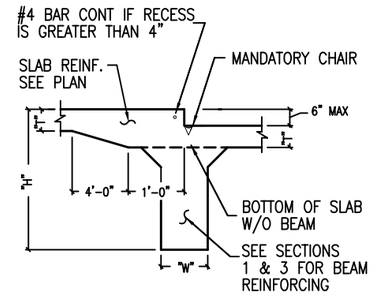
1. SITE, SUBGRADE, CONCRETE AND CURING SHALL CONFORM TO ACI 302 "RECOMMENDED PRACTICE FOR CONCRETE FLOOR AND SLAB CONSTRUCTION."
2. SITE GRADING AND DRAINAGE AROUND FOUNDATION SHALL BE MAINTAINED AT ALL TIMES IN SUCH A MANNER THAT SURFACE WATER WILL NOT COLLECT AROUND SLAB. ADEQUATE POSITIVE DRAINAGE SHALL BE PROVIDED SLOPING AWAY FROM FOUNDATION WITH A MINIMUM SLOPE OF 2–5% (1/4–5/8 IN/FT) FOR A MINIMUM DISTANCE OF 5' –0" FROM FOUNDATION EDGE.
3. FINAL GRADES SHALL HAVE POSITIVE DRAINAGE (SLOPING AWAY FROM SLAB). A MINIMUM OF 6" CLEARANCE BETWEEN TOP OF SLAB AND OR BRICK–LEDGE AND SOIL SURFACE SHALL BE MAINTAINED.
4. BEAM TRENCHES SHALL BE CLEAN PER PLAN. BEAM BOTTOMS SHALL BE FOUNDED IN AT LEAST 12" OF UNDISTURBED SOIL OR PROPERLY COMPACTED FILL UNLESS PIERS HAVE BEEN SPECIFIED.
5. AT CONTRACTORS EXPENCE, A SAND CUSHION OR THIN LAYER OF SELECT FILL MAY BE USED AS TOP LAYER FOR PAD. EXISTING SOILS MAY BE USED AS LONG AS THEY PRESENT NO HAZARD TO POLY VAPOR BARRIER.
6. A LAYER OF 6 MIL POLYETHYLENE WITH LAPPED JOINTS BETWEEN SAND/ EXISTING MATERIAL AND SLAB IS REQUIRED UNLESS INDICATED OTHERWISE.
7. SLAB REINFORCING BARS SHALL BE SUPPORTED BY CHAIRS SPACED AT A 4' MAXIMUM INTERVAL, AND TIED AT ALL INTERSECTIONS TO PREVENT MOVEMENT DURING CONCRETE PLACEMENT.
8. CONSTRUCTION JOINTS ARE PROHIBITED UNLESS INDICATED OTHERWISE.
9. CONCRETE SHALL BE VIBRATED TO ENSURE CONSOLIDATION.
10. CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND CONDITIONS PRIOR TO CONSTRUCTION AND NOTIFY ENGINEER OF ANY DISCREPANCIES.
11. WHERE DISCREPANCIES BETWEEN FOUNDATION PLAN AND ARCHITECTURAL PLANS ARE NOTED, ARCHITECTURAL PLANS SHALL CONTROL.
12. COORDINATE STRUCTURAL DRAWINGS WITH ARCHITECTURAL DRAWINGS FOR ALL OPENINGS, DROPS, INSERTS, SLOPES, BRICK–LEDGES AND RELATED ITEMS.
13. IF SOLID ROCK IS ENCOUNTERED DURING TRENCHING OF BEAMS, BEAM DEPTH MAY BE REDUCED, BUT MUST MAINTAIN A MINIMUM OF 12" SOIL COVER UPON FINAL GRADE.
14. PLUMBING LINES SHALL NOT BE LOCATED ALONG SIDE OR IN BEAM TRENCHES.
15. SIDEWALKS AND DRIVES SHALL BE GRADED TO SLOPE AWAY FROM FOUNDATION TO ELIMINATE AND PREVENT PONDING OF WATER.
16. TREES AND SHRUBS SHOULD NOT BE LOCATED CLOSER TO FOUNDATION THAN A HORIZONTAL DISTANCE EQUAL TO ROUGHLY ONE – HALF THE MATURE HEIGHT OF TREE OR SHRUB UNLESS PIERS ARE SPECIFIED.

LIMITATIONS

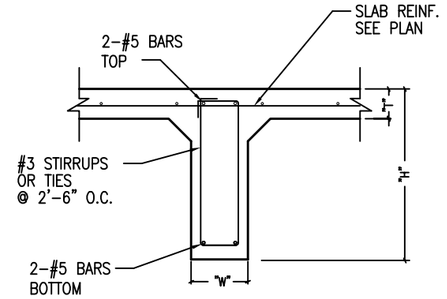
1. A PRE–POUR INSPECTION IS REQUIRED BY THE ENGINEER OF RECORD.
2. IN THE EVENT A SOILS REPORT FOR THE SPECIFIC TRACT OF LAND UPON WHICH THE PROPOSED STRUCTURE IS TO BE CONSTRUCTED IS PROVIDED, THE ENGINEER WILL RELY ON INFORMATION CONTAINED IN SAID SOILS REPORT IN DESIGNING PLANS AND SPECIFICATIONS. HOWEVER, THE ENGINEER DOES NOT ASSUME OR TAKE ANY RESPONSIBILITY WHATSOEVER FOR THE ACCURACY OF SAID SOILS REPORT, OR ANY INFORMATION CONTAINED THEREIN FOR WHICH THE ENGINEER MAY HAVE RELIED UPON TO DESIGN THE FOUNDATION FOR THE PROPOSED STRUCTURE. IF NO SOILS REPORT IS PROVIDED, THE ENGINEERED DESIGN WILL BE BASED SOLELY ON AVERAGE SOIL CONDITIONS IN GENERAL LOCATION OF PROPOSED CONSTRUCTION SITE. AS A RESULT, THE ENGINEER MAKES NO GUARANTEE, WARRANTY, OR REPRESENTATION AS TO THE ADEQUACY OF DESIGN FOR THE PARTICULAR TRACT OF LAND UPON WHICH THE CLIENT PROPOSES TO CONSTRUCT A STRUCTURE. RATHER THE ENGINEER WILL WARRANT THE DESIGN TO BE FREE OF DEFECTS IF CONSTRUCTED UPON SOIL SUBSTANTIALLY SIMILAR IN ALL RESPECTS TO AVERAGE SOIL CONDITIONS FOR THE AREA.
3. MOISTURE CONTENT OF SOILS LOCATED AT JOBSITE ARE ANTICIPATED TO FLUCTUATE SEASONALLY DEPENDING ON AMOUNT OF RAINFALL/WEATHER PATTERNS, SURFACE DRAINAGE AND SUBSURFACE DRAINAGE CHARACTERISTICS.
4. FOR FOUNDATION TO PERFORM AS DESIGNED OWNER MUST ENSURE THAT SOIL MOISTURE CONTENT IS MAINTAINED AT A CONSTANT LEVEL SURROUNDING FOUNDATION. DO NOT ALLOW SOIL TO DRY OUT TO A POINT WHERE THE SOIL CRACKS OR PULLS AWAY FROM FOUNDATION.
5. TO REDUCE CRACKING IN FOUNDATION, ADEQUATE POSITIVE DRAINAGE SHALL BE PROVIDED SLOPING AWAY FROM THE FOUNDATION WITH A MINIMUM SLOPE OF 2%.



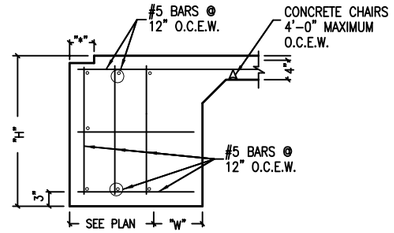
SECTION 1
NTS



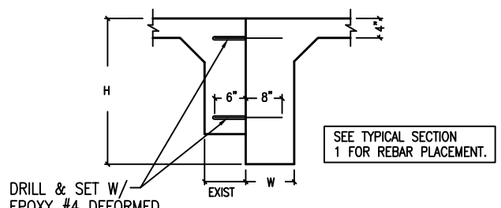
SECTION 2
NTS



SECTION 3
NTS



SECTION 4
NTS



SECTION 5
NTS

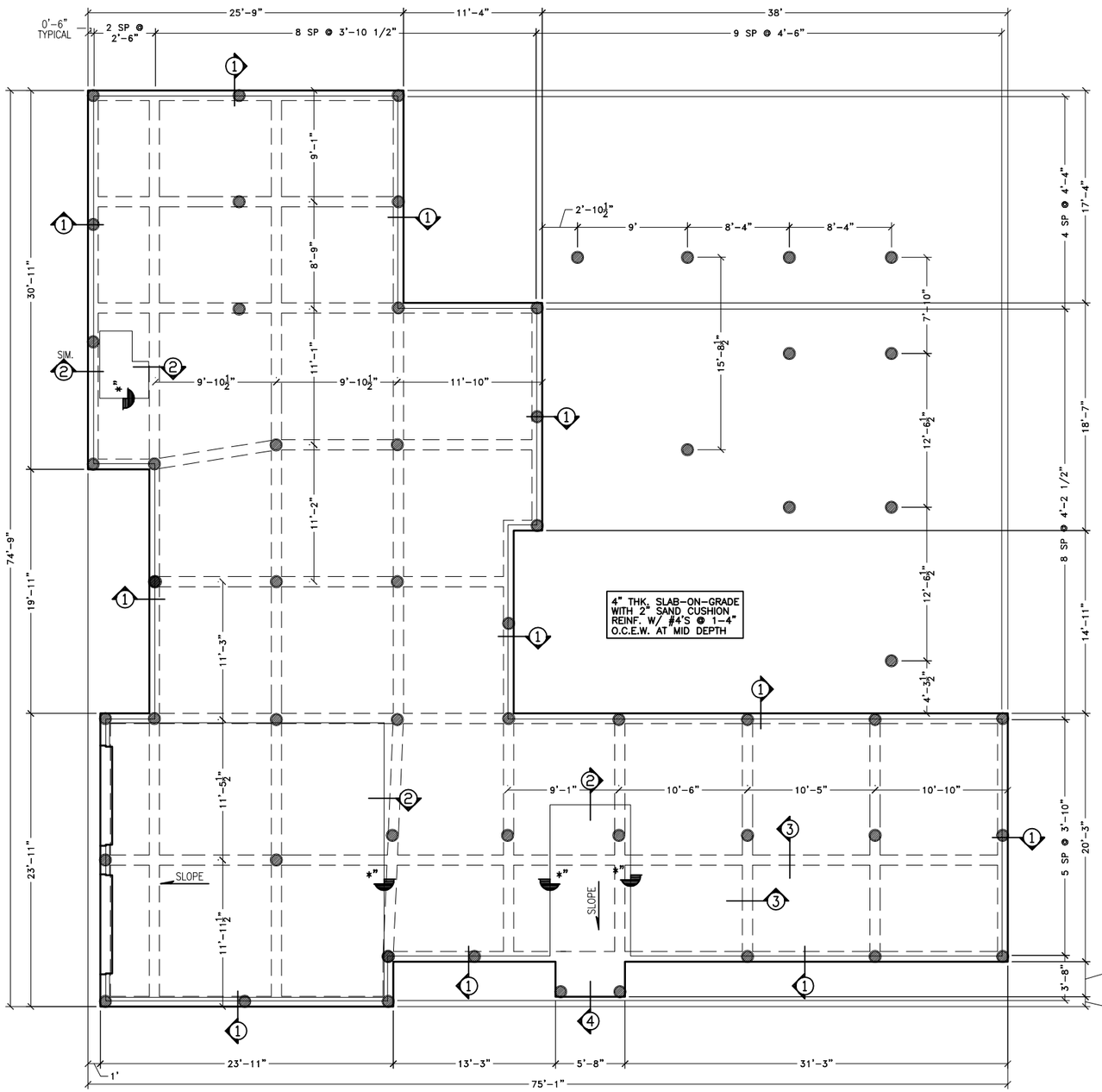
THIS FOUNDATION DESIGN IS APPLICABLE TO THE SPECIFIC PROJECT AND LOCATION LISTED ON THIS SHEET. USE OF THIS DRAWING FOR OTHER PROJECTS AND/OR LOCATIONS IS PROHIBITED.

STATE OF TEXAS
ERIC L. DAVIS
86895
LICENSED
PROFESSIONAL ENGINEER

GENERAL NOTES
&
TYPICAL SECTIONS FOR
CONVENTIONALLY REINFORCED FOUNDATIONS
ERIC L. DAVIS ENGINEERING, INC.
FIRM REGISTRATION #F–3987

CONTRACTOR SHALL WATER PAD 72 HOURS CONTINUOUS PRIOR TO CONSTRUCTION OF FOUNDATION.

REVISIONS	CODE
6/1/09 CONVERT FROM PT TO REBAR JSB	T



DRILLED PIERS:

1. ALL DRILLED PIERS SHALL BE 12" IN DIAMETER WITH 1-#5 BAR VERTICAL.
2. PIERS SHALL BE PLACED A MINIMUM DEPTH OF 17'-0" (BELOW THE BEAM) INTO UNDISTURBED SOILS OR COMPACT FILL, UNLESS SOLID ROCK IS ENCOUNTERED. IF SHALE IS ENCOUNTERED AT A DEPTH OF 11'-0" OR LESS, PIERS MAY TERMINATE AFTER PENETRATING THE SHALE A MINIMUM OF 4'-0".

STATE OF TEXAS
ERIC L. DAVIS
86895
LICENSED
PROFESSIONAL ENGINEER

NOTES:

1. SLAB THICKNESS T = 4"
2. BEAM DEPTH H = 28"
3. BEAM WIDTH W = 12"

PLAN LEGEND

1. A DENOTES CONCRETE CHAIR.
2. "*" DENOTES DIMENSION TO BE VERIFIED.
3. "XX" DENOTES DIFFERENCE IN FINISH FLOOR ELEVATIONS.

4/22/2009

ERIC L. DAVIS ENGINEERING, INC.
425 Pinson Road Suite "C"
Forney, Texas 75126
972/564-0592 Fax 972/564-6523
E-Mail ericdavis@eldengineering.com

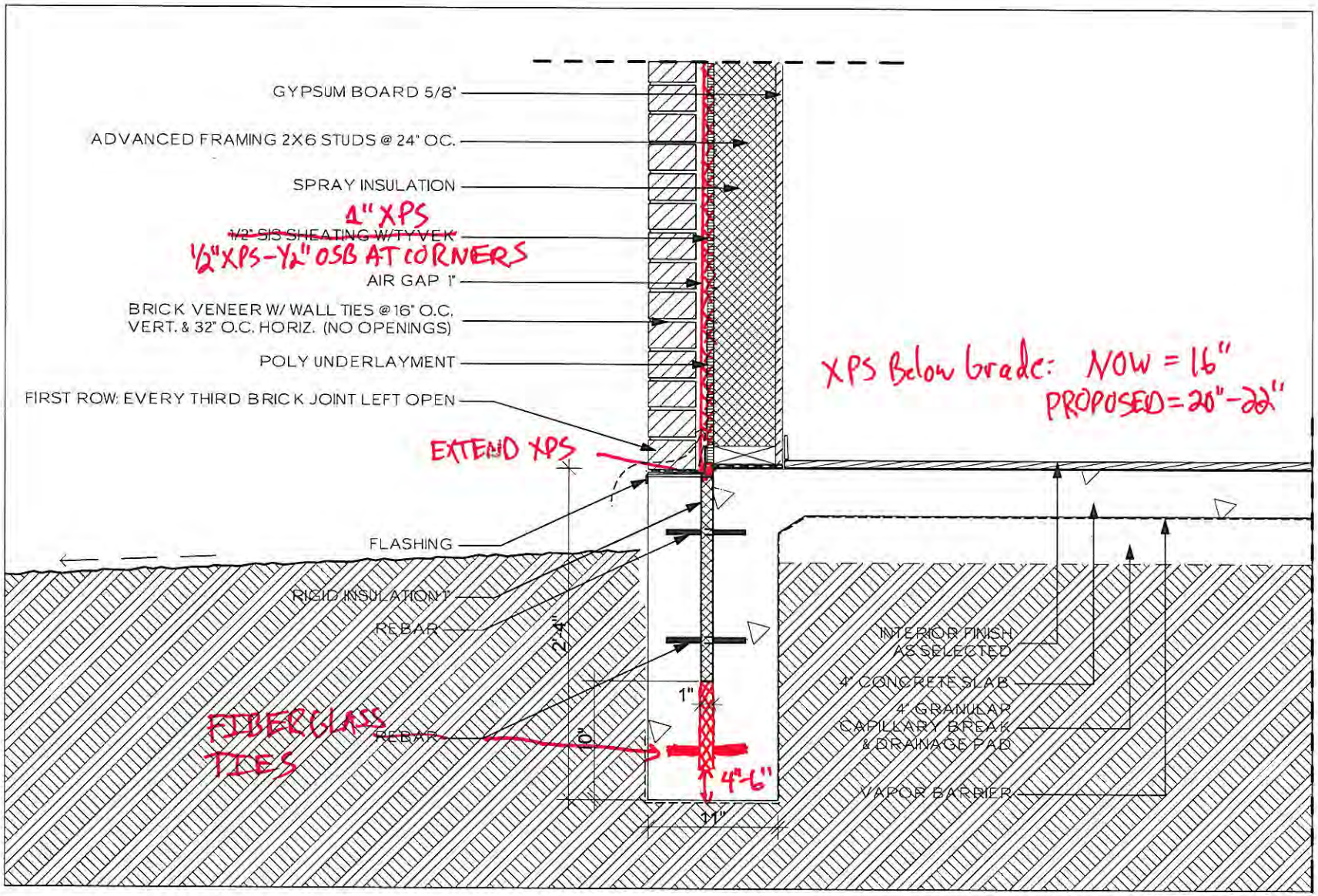
FOUNDATION PLAN
ENGINEERED FOR:
POTTER CONCRETE RESIDENTIAL, LTD

BUILDER: POTTER CONCRETE RESIDENTIAL, LTD
ADDITION: PRIVATE RESIDENCE
ADDRESS: 937 TIMBERCREEK DRIVE
LOT: 9 BLOCK: A
CITY: LEWISVILLE, TEXAS

PLAN: CUSTOM
ELD JOB NO.: DI09-141
DRAWN BY: JSB
CHECKED BY: ELD (F-3987)
AREA: 3,158 SQ. FT.

SCALE: 3/32"=1'-0"

SHEET 1 OF 1

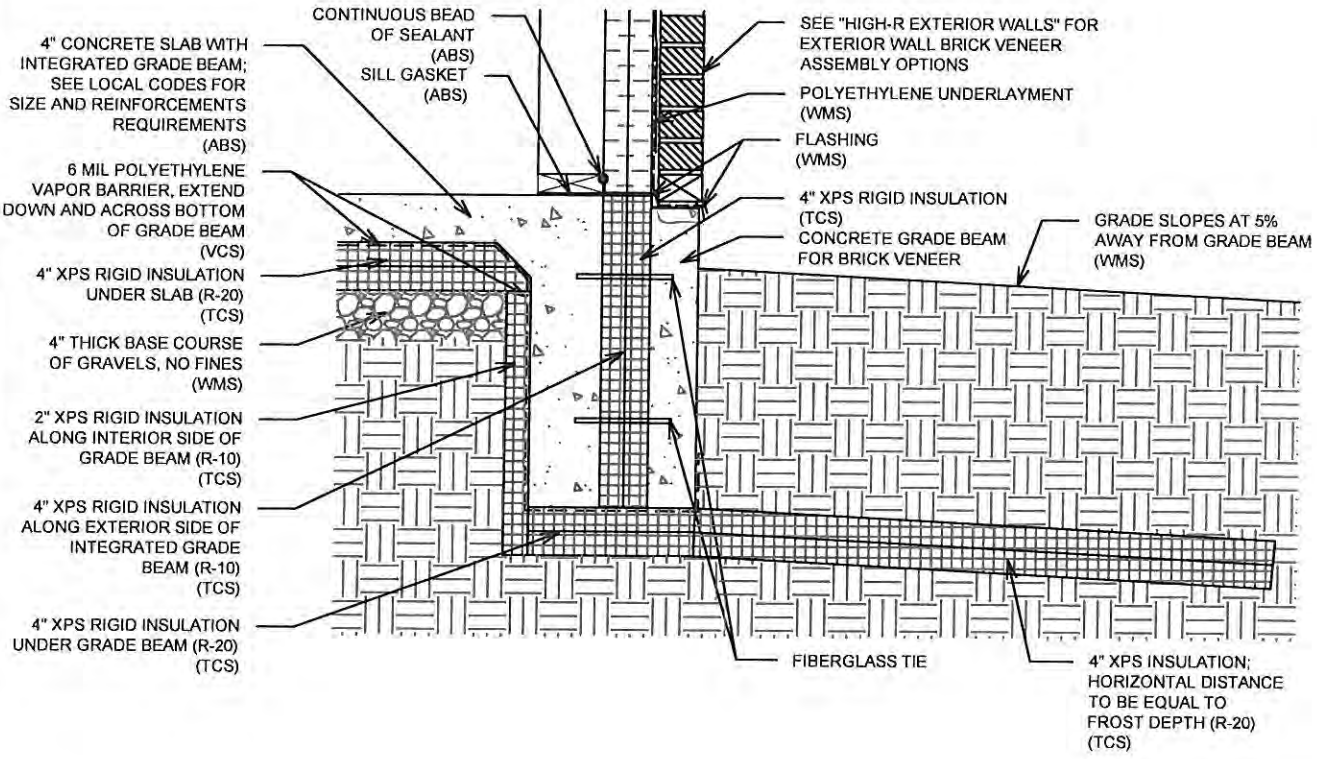

GYPSUM BOARD 5/8"
ADVANCED FRAMING 2X6 STUDS @ 24" OC.
SPRAY INSULATION
1" XPS
~~1/2" SIS SHEATING W/TYVEK~~
1/2"XPS-Y2" OSB AT CORNERS
AIR GAP 1"
BRICK VENEER W/ WALL TIES @ 16" O.C. VERT. & 32" O.C. HORIZ. (NO OPENINGS)
POLY UNDERLAYMENT
FIRST ROW: EVERY THIRD BRICK JOINT LEFT OPEN
EXTEND XPS
XPS Below Grade: NOW = 16"
PROPOSED = 20"-22"
FLASHING
RIGID INSULATION 1"
REBAR
FIBERGLASS TIES
REBAR
2'-4"
10"
1"
4"-6"
11"
INTERIOR FINISH AS SELECTED
4" CONCRETE SLAB
4" GRANULAR CAPILLARY BREAK & DRAINAGE PAD
VAPOR BARRIER

SCALE : 1" = 1'-0"

Foundation: CONCRETE GRADE BEAM INTEGRAL WITH SLAB
Slab on Grade Type: MONOLITHIC SLAB
Location of Insulation: BELOW SLAB, ENCLOSING GRADE BEAM, AND HORIZONTAL FROST PROTECTION
Drying: TO INTERIOR
Insulation Type, Insulation R-Value:
BELOW SLAB: 4" XPS RIGID INSULATION, R-20
EXTERIOR OF GRADE BEAM: 4" XPS RIGID INSULATION, R-20
INTERIOR OF GRADE BEAM, 2" XPS RIGID INSULATION, R-20
BELOW GRADE BEAM: 4" XPS RIGID INSULATION, R-20
FROST PROTECTION: 4" XPS RIGID INSULATION, R-20

Appropriate for Cold Climates

ABS: *Air Barrier System component*
TCS: *Thermal Control System component*
VCS: *Vapor Control System component*
WMS: *Water Management System component*



bsc with Building America — U.S. Department of Energy — Research Toward Zero Energy Homes

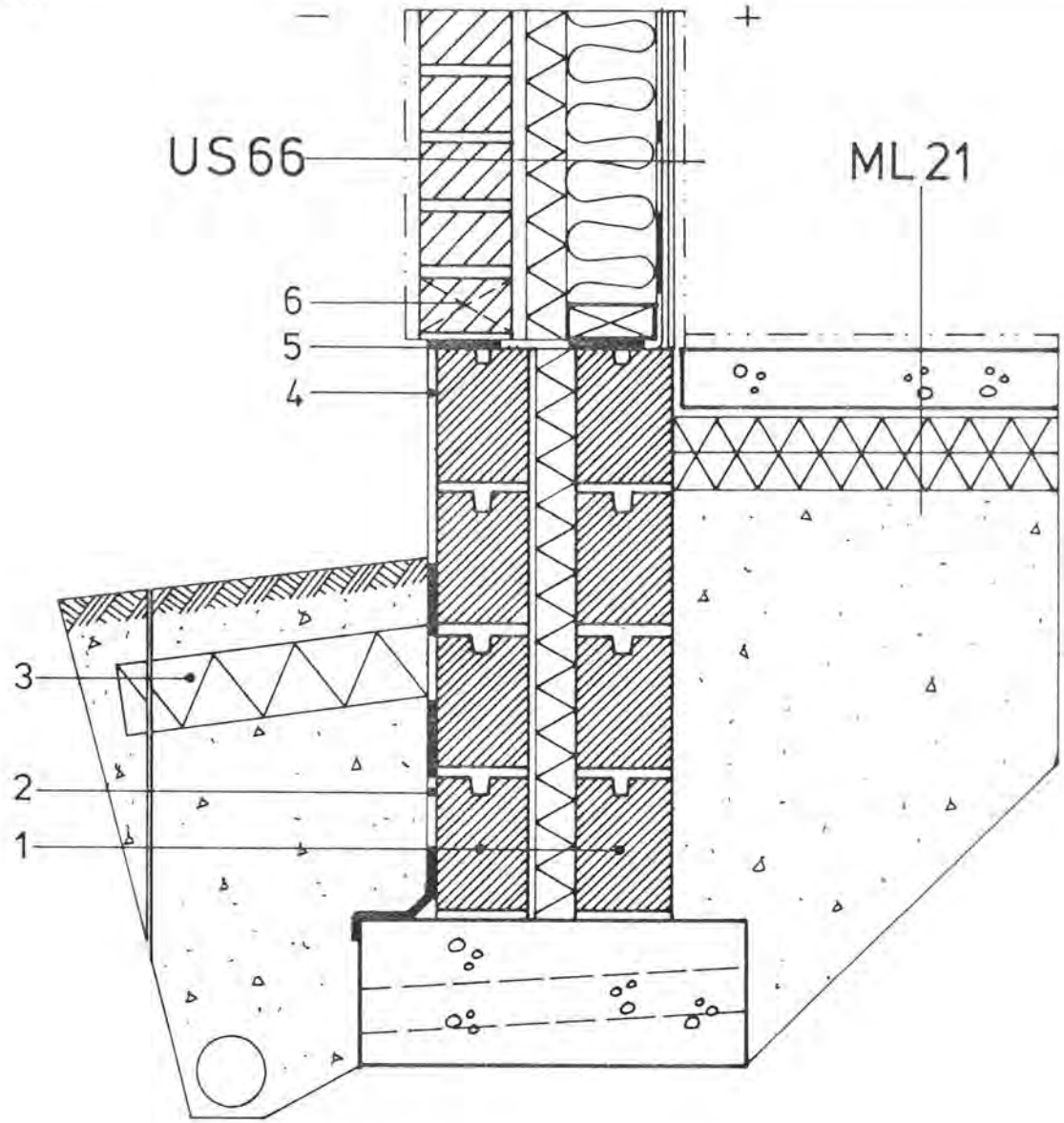
Project: High-R Foundation Walls
Date: 2009-06-03
Drawing Title: Foundation Walls
Drawing File: FoundationDetails.dwg
Drawing Scale: 3/4" = 1'-0"

Sheet Title:

SG Type #1A

Rakennuskohde	Tekijä	Muutos	P4
	Päiväys		
Suunnittelija	Sisalto **Rakennedetalji** **Perustus** **2.20—4**		

Mittakaava 1:10



1 HARKKOPERUSTUS
Saka harkot 285x135x185 mm + sokkeli-halkaisu polystyreeni Styrox N 50 mm

2 KOSTEUDENERISTE
Pato-levy

100 mm 3 ROUDANERISTE
polystyreeni Styrox R

4 SOKKELIN PINTAMATERIAALI TAI -KÄSITTELY
- rappaus

5 KOSTEUDENERISTE
bitumihuopa EL 50/2200

6 TUULETUS
joka kolmas pystysauma jätetään auki

GreenCraft BUILDERS L.L.C.

presents

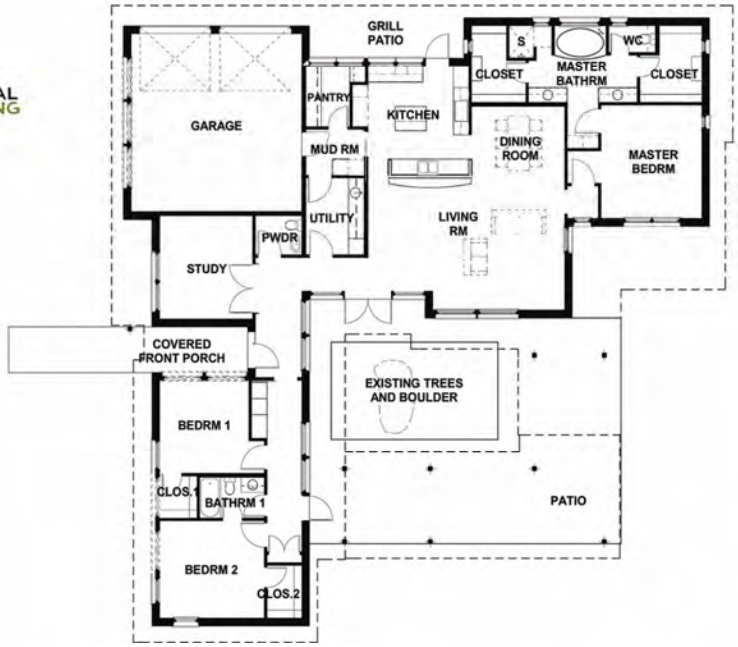
TimberCreek Zero Energy House

www.timbercreekzerohouse.com

The TimberCreek Zero Energy House will be a 2500 square foot demonstration project for the Department of Energy's "Building America" program to encourage homeowners and builders to take the next step in living and building in a more fiscally and environmentally sensible manner. This home will incorporate renewable energy resources as well as eco friendly materials and building practices to achieve a high-performance "net zero" home with minimal impact on the environment.

Accredited by

Building America U.S. Department of Energy · U.S. Green Building Council · Green Built North Texas · bsc · Energy Star · NAHB National Green Building Program™



GreenCraft BUILDERS L.L.C.

TimberCreek Zero Energy House

Previous Show Homes

Bannister House

The Colleyville Eco House

Overview: The TimberCreek Zero Energy House

Designed by William Peck & Associates of Lewisville, Texas, an winning architect known for his designs of green, energy efficient homes.

Built by Chris Miles of GreenCraft Builders LLC a recipient of the 2009 EVHA Award and builder of:

- 2008-09 "Colleyville Eco House"
- 2007 "Bannister High-Performance House"
- Producer of the 2004 Zero Energy Home, and the 2005 Lewisville Hardie Home.

Supported by

- US Department of Energy's "Build America" Program
- Building Science Consortium
- USGBC Leed H
- NAHB Green Build Guidelines
- Green Built North Texas

On display

- 4 weekends October/November 2009
- Builder Events:
  - Sunbelt Builder Show
  - Green Built North Texas

Building America U.S. Department of Energy · U.S. Green Building Council · Green Built North Texas · NAHB National Green Building Program · energy star · bsc

GreenCraft BUILDERS L.L.C.

Public Relations and Event Marketing

The House will be promoted by a Public Relations and Event Marketing campaign as follows:

Feature stories in consumer magazines and newspapers.

Television segments on Dallas/Fort Worth network affiliates.

House Talk Radio Show bi-monthly construction update interviews on NewsTalk 660 KSKY, hosted by Chris Miles.

Trade print to include Builder Insider and Texas Builder Magazine

Internet marketing to news, consumer, trade and specialty sites.

- www.greencraftbuilders.com
- www.housetalktoday.com
- Past sites include www.colleyvilleecohouse.com www.bannisterhousetexas.com

GreenCraft Newsletter with over 1000 subscribers

TimberCreek Zero Energy House

Previous Show Homes

Bannister House

The Colleyville Eco House

Building America U.S. Department of Energy

U.S. Green Building Council

Green Built North Texas™

NAHB National Green Building Program™

Energy Star

bsc

GreenCraft BUILDERS L.L.C.

Recent Event Highlights and Results

TimberCreek Zero Energy House

Previous Show Homes

Bannister House

The Colleyville Eco House

2008 – 09 Colleyville Eco House

- Open 4 weekends March 09 – 4400 attendees
- Sunbelt Builders Show – 180 builders
- 2009 NAHB National Green Conference – 300 builders
- Press and Advertising
  - Multiple feature stories and articles in the Dallas Morning News, Ft Worth Star-Telegram, and the Colleyville/Grapevine Newspaper.
  - Channel 13 KERA Television
  - KERA NPR Radio
  - HouseTalk Radio
  - Fox 4, NBC 5, WFAA 8, KTVT CBS 11, TXA21, CW33.
  - House and Home Magazine
  - Panache Magazine
  - GreenCraft Newsletter

Building America U.S. Department of Energy · U.S. Green Building Council · Green Built North Texas™ · NAHB National Green Building Program™ · energy · bsc

GreenCraft BUILDERS L.L.C.

Recent Event Highlights and Results

TimberCreek Zero Energy House

Previous Show Homes

Bannister House

The Colleyville Eco House

2007 Bannister High Performance House

- Open 4 weekends Sept/Oct 07 – 3800 attendees
- Sunbelt Builders Show – 150 builders
- Green Built North Texas – 85 Builders
- Certified Master Builder Corp – 100 Builders
- Press and Advertising
  - Multiple feature stories, articles and event mentions in Dallas Morning News and Ft Worth Star-Telegram, Grapevine/Colleyville Newspaper
  - Channel 13 KERA Television
  - HouseTalk Radio
  - Fox 4, NBC 5, WFAA 8
  - House and Home Magazine
  - GreenCraft Newsletter

Building America U.S. Department of Energy · U.S. Green Building Council · Green Built North Texas™ · NAHB National Green Building Program™ · energy · bsc

GreenCraft BUILDERS L.L.C.

Benefits to Your Company

TimberCreek Zero Energy House

Previous Show Homes

Bannister House

The Colleyville Eco House

Category exclusivity for your product in the construction of the home

A comprehensive PR and Media Campaign to promote The TimberCreek Zero Energy House by Shiroma Southwest

Overview of Campaign Elements:

- **PR campaign targeting the trade and general public**
  - print, radio, TV and Internet
  - to run May – November, 2009
- **Promotion to the general public & trade**
  - Construction Open House July, 2009
  - Single site tour held over 4 weekends starting October/November, 2009
  - Specific builder events
- **Advertising schedule** in Dallas/Ft.Worth
  - TV, radio, and Internet
  - May – November, 2009

Building America U.S. Department of Energy

U.S. Green Building Council

Green Built™ North Texas

NAHB National Green Building Program™

energy

bsc

GreenCraft BUILDERS L.L.C.

TimberCreek Zero Energy House

Previous Show Homes

Bannister House

The Colleyville Eco House

Trade Events

The TimberCreek Zero Energy House will host events for various trade associations:

- **Sunbelt Builder Show – Oct 29 – 31, 2009**
- **North Texas Chapter, American Institute of Architects (AIA)**
- **Home Builders Association of Greater Ft Worth (HBA)**
- **Green Built North Texas (Dallas HBA)**
- **USGBC North Texas chapter**

Building America U.S. Department of Energy

U.S. Green Building Council

Green Built North Texas™

NAHB National Green Building Program™

Energy Star

bsc

GreenCraft BUILDERS L.L.C.

TimberCreek Zero Energy House

Previous Show Homes

Bannister House

The Colleyville Eco House

Value and Cost

Value to you:

Total advertising, PR and media value for this house will exceed $250,000.

Sponsorship Levels:

- **Level A:** Naming Rights Sponsor
- **Level B:** Presenting Sponsor providing product plus dollars
  - includes listing on all brochures, flyers, website, and radio that promote the products donated to the construction of this home
- **Level C:** Product-only Sponsor

Building America U.S. Department of Energy · U.S. Green Building Council · Green Built North Texas · NAHB National Green Building Program · Energy Star · bsc

GreenCraft BUILDERS L.L.C.

TimberCreek Zero Energy House Design Features:

TimberCreek Zero Energy House

Previous Show Homes

Bannister House

The Colleyville Eco House

Proper Solar Orientation
Termimesh Chemical Free Termite Barrier System
Advanced Framing 2x6 24 o.c.
95% Recycled Content Sheetrock
Galvalume Standing Seam Metal Roof
95% Recycled Content Garage Doors
Low-e Insulated Windows
Open & Closed Cell Spray Foam Insulation
Conditioned Attic
High SEER Heat Pump
Fresh Air Intake with ERV
Central Dehumidification System
Solar Hot Water
Tankless Water Heaters
Rainwater system for irrigation
Low Flow Faucets
Dual Flush Toilets
Water Wise Landscaping
Energy Star Appliances
100% Compact Fluorescent Lighting
8 kw Photovoltaic System
Recycled Glass Countertops & Floors
FSC Certified Wood Used for Interior Trim and Cabinets
Low/No VOC Paints

Building America U.S. Department of Energy

U.S. Green Building Council

Green Built North Texas™

NAHB National Green Building Program™

energy

bsc

GreenCraft BUILDERS L.L.C.

Architect: William Peck AIA

William Peck & Assoc., INC.
Lewisville, TX

- **Specializes in sustainable or "green" residential and commercial building practices**
- **Implements practical "green" building techniques including passive cooling strategies and radiant barriers**
- **Energy-efficient and accessible designs include the 2005 Lewisville Hardie House and the widely acclaimed Bannister High Performance House**
- **Recipient of the *Best Achitectural Design* award, Fort Worth, Texas Kaleidoscope of Homes**
- **Winner of the 2008 & 2009 Energy Value Housing Award (EVHA) and the 2009 EVHA *Peoples Choice* award**
- **Designer of a wide variety of projects including for senior housing and accessed challenged clients**
- **Serves as a University of North Texas Faculty Associate**
- **Is dedicated to educating city officials and the general public about the benefits of sustainable, energy efficient, design and building.**

TimberCreek Zero Energy House

Previous Show Homes

Bannister House

The Colleyville Eco House

Building America U.S. Department of Energy

U.S. Green Building Council

Green Built™ North Texas

NAHB National Green Building Program™

energy

bsc

GreenCraft BUILDERS L.L.C.

Builder: Chris Miles

GreenCraft Builders, LLC.
Lewisville, TX

TimberCreek Zero Energy House

Previous Show Homes

Bannister House

The Colleyville Eco House

- **Builder and remodeler since 1977**
- **2009 Energy Value Housing Award (EVHA) silver winner**
- **2009 EVHA Peoples Choice award**
- **Student of Building Science with field experience per the guidelines developed by the U.S. Department of Energy "Building America" program**
- **Homes include certifications by U.S. Department of Energy "Building American" program, United States Green Build Council, Green Built North Texas, and NAHB Green Build Program**
- **Builder of the 2007 LEED-Platinum *Bannister High Performance House* under the auspices of Building Science Consortium and Building America**
- **Builder of the LEED-H Gold and NAHB Green Built Gold *Colleyville Eco House***
- **Host of the popular "HouseTalk" Radio Program currently in it's 14th year on NewsTalk 660 KSKY AM and 92.9 FM**
- **Founding member and 2009 Chairman of the Green Built North Texas (GBNT) through the Dallas Home Builders Association.**

Building America U.S. Department of Energy · U.S. Green Building Council · Green Built North Texas · NAHB National Green Building Program · Energy Star · bsc

GreenCraft BUILDERS L.L.C.

TimberCreek Zero Energy House

Previous Show Homes

BANNISTER HOUSE

THE COLLEYVILLE ECO HOUSE

Next Step for Participation

Please contact Chris Miles:

- **Phone: (214) 718-8424**
- **Email: chris@greencraftbuilders.com**

Appendix D.8.7.2
Energy Modeling

March 02, 2009

Chris Miles
GreenCraft Builders LLC
105 W. Main Street
Lewisville, Texas
214-718-8424

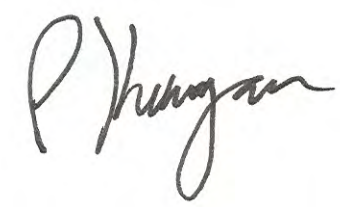
Building America Performance Analysis of the Lewisville House

Dear Mr. Miles,

BSC has completed initial energy analysis for the 2009 Greencraft Zero Net Energy house in Lewisville, Texas. The analysis shows that the plan has a source energy consumption reduction of 70.5% relative to the Building America Benchmark Protocol. The following is a detailed explanation of the analysis and results as well as a discussion on the various attributes of the plan.

BSC will meet with Greencraft regarding the design of the Lewisville Eco House during the second week in March while onsite testing the 2009 Colleyville House.

Sincerely,



Philip Kerrigan Jr., PE
Building Science Corporation

Daniel Bergey
Building Science Corporation

1. Building Plan and Specifications

The building characteristics used in this analysis are listed below. Details of the analysis are included later in the report.

Floor area (ft^2)	Surface Area (ft^2)	Volume (ft^3)	Glazing Ratio (%)
4886	12598	76929	18.9%

Building envelope	
Ceiling	R-30 spray foam at roof deck to create Conditioned attic Icynene®
Walls	2x6, 24" oc framing with 3/4" XPS with R-19 Spray foam Icynene®
Foundation	51% Flyash concrete monolithic slab with Termimesh termite control
Windows	Pella ® fiberglass LoE^3 (U=0.28, SHGC=0.24)
Infiltration	2.5 sq in leakage area per 100 sf envelope

Mechanical systems	
Heat	9 HSPF AAON air source heat pump in conditioned UV attic
Cooling	17 SEER AAON air source heat pump in conditioned UV attic
Dehumidification	Modulating gas reheat coil on AAON air source heat pump
DHW	Instantaneous Hot Water EF=0.82
Ducts	R-8 flex runouts in unvented attic or in floor joists
Ventilation	ERV Fantech SER Series Supply-only system integrated with AHU 33% Duty Cycle: 10 minutes on; 20 minutes off, 50 CFM average flow
Return Pathways	Jump ducts at bedrooms and laundry

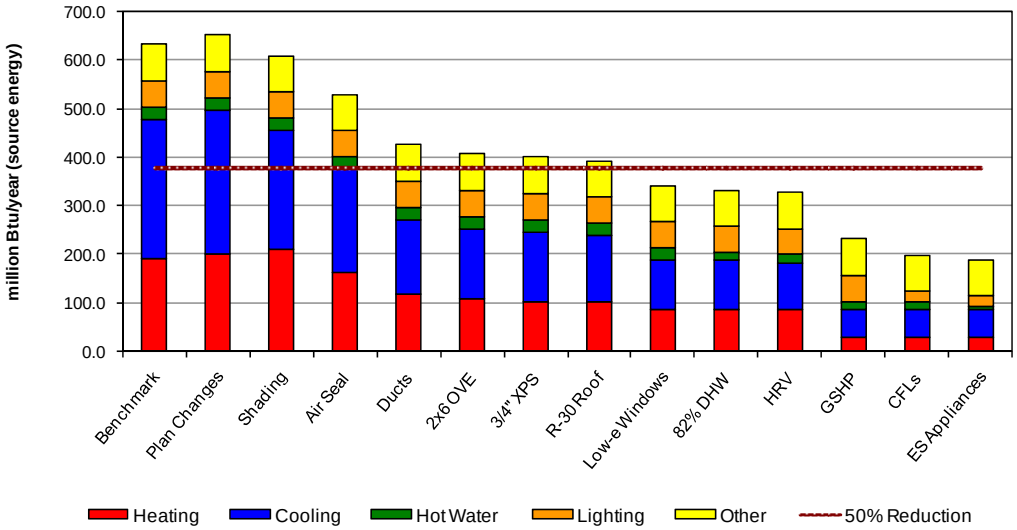
Lights/Appliances/MELs	
Lights	Full CFL lighting
Appliances	Energy Star clothes washer, dishwasher and refrigerator

2. 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).

Each parametric step shows an increment over source energy use (IOSEU) over the Building America Benchmark Protocol for the change to the model. This can be used to evaluate the relative effects of each performance upgrade made to the model. Due to rounding error, the sum of incremental improvements does not precisely match the total improvement for all measures. Each step is described below and the results are discussed.

Parametric Annual Loads Study



1. Plan Changes: This step reflects the difference in window distribution between the Benchmark and the planned house.
2. 1+ Shading: This step accounts for the shading provided by roof overhangs. Taken together with the previous step, the savings is 3.7% of Benchmark energy usage.
3. 2 + Air Seal: This step brings the modeled house to Building America targets for air infiltration. The IOSEU for this step was 12.5%.
4. 3 + Ducts to interior: In this step, all ductwork was well sealed and brought to the interior, greatly reducing leakage to outside. The IOSEU for this step was 16.6%.
5. 4 + 2x6 OVE Framing: Advanced framing on 24" centers saves labor while reducing thermal bridging in the walls. 2x6 walls provide space for R-19 cavity insulation, resulting in an IOSEU of 3.2%.
6. 5 + Insulating Sheathing: ¾" of XPS sheathing was added to the exterior of all exposed walls, for an IOSEU of 1.0%.
7. 6 + R-30 attic insulation: The ceiling insulation was increased from R-25 to R-30. This upgrade results in an IOSEU of 1.2%.
8. 7 + U=0.28, SHGC=0.24 Windows: All windows were set to those to be installed, for an IOSEU of 8%.
9. 8 + 0.82 EF Instantaneous gas hot water: A gas hot water tank with an EF rating of 0.56 was replaced with a high efficiency instantaneous gas hot water system. This resulted in an IOSEU of 1.5% for this step.

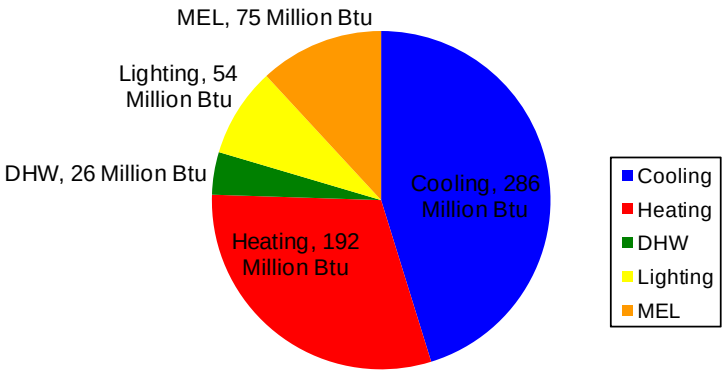
10. 9 + HRV: A heat recovery ventilator was added to the central air system. The IOSEU for this step was 0.7%.
11. 10 + GSHP: A ground source heat pump with a COP of 5.0 was modeled. The IOSEU for this step was 17.5%.
12. 11 + CFLs: All light fixtures in the modeled house were provided with compact fluorescent bulbs. The IOSEU was 5.3%.
13. 12 + ES Appliances: The dishwasher, clothes washer, and refrigerator were replaced with Energy Star rated models. The IOSEU for this step was 1.9%
14. 10+ 80% Compact fluorescent lighting: The lighting scheme was changed from a 14% CFL lighting package to an 80% CFL package for all hard wired lights. This resulted in a IOSEU of 4.2% for this step.

		Total Source Energy Savings (H/C/DHW/Lights/Appliances/Plug)						
Parametric Run ID	**Description of change**	**% over BA Bmrk**	**Incr. Over Bmrk**	**Annual energy cost**	**Item Savings**	**HERS Score**	**Heating Load**	**Cooling Load**
							kBtuh	kBtuh
0	Benchmark			$5,602		142	174.4	197.7
1	Windows as-designed	-3.2%	-3.2%	$5,777	($175)	142	170.4	178.6
2	Porches and overhangs	3.7%	6.9%	$5,399	$378	130	175.7	188.2
3	Air Seal (2.5 Leakage Ratio)	16.2%	12.5%	$4,708	$691	114	130.2	147.2
4	Ducts 5% leakage and in cond. space	32.8%	16.6%	$3,795	$913	92	96.8	83.9
5	R-19 OVE Walls	35.7%	3.0%	$3,632	$163	89	90.7	80.1
6	3/4" XPS	36.8%	1.0%	$3,575	$58	87	89.4	79.4
7	R-30 Roof	38.0%	1.2%	$3,506	$69	85	88	78
8	Windows Low-e (U=0.28, SHGC=0.24)	46.0%	8.0%	$3,064	$442	74	73.4	56.5
9	0.82 EF Inst. DHW	47.5%	1.5%	$2,968	$96	70	73.4	56.5
10	HRV	48.1%	0.7%	$2,931	$37	69	72.4	55.5
11	WaterFurnace GSHP COP=5	63.3%	17.5%	$2,094	$965	53	72.4	55.5
12	CFL Lighting	68.6%	5.3%	$1,802	$292	48	72.4	55.5
13	ES Appliances	70.5%	1.9%	$1,680	$122	47	72.4	55.5

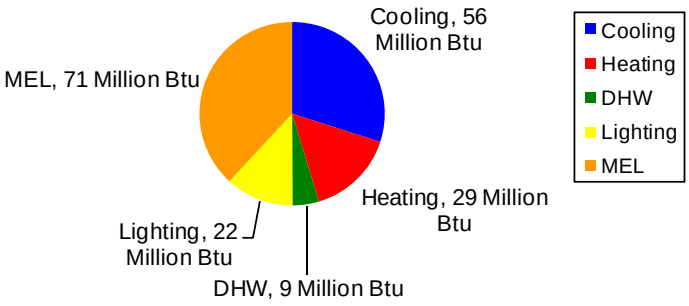
3. Energy Components

The pie charts below reflect the component energy use for benchmark and the BA characteristics model. Because most of the savings were in heating and cooling, the plug loads, which are dependent on occupant behavior, and not on the building design, form a larger fraction of the total load.

Benchmark Component Energy Use



Prototype Component Energy Use



4. End Use Site and Source Energy

GreenCraft: Colleyville House

ESTIMATED WHOLE HOUSE ENERGY USE		
Source (10^6 BTU/yr)	**Site (10^6 BTU/yr)**	**Area + Bsmt (sq ft)**
189	69	4886 + 0
	% Electric	**No. of Bedrooms**
	72%	4

Table 1. Summary of End-Use Site-Energy

	Annual Site Energy			
	Manual Benchmark		Prototype	
End-Use	kWh	therms	kWh	therms
Space Heating	16656	0	2411	0
Space Cooling	24886		4782	
DHW	0	236	0	80
Lighting*	4717		1946	
Appliances + Plug	5695	114	5293	114
OA Ventilation**	112		178	
Total Usage	52064.75	350	14610	194
Site Generation	0		0	
Net Energy Use	52065	350	14610	194

*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	
			% of End-Use	% of Total
End-Use	Manual Benchmark 10^6 BTU/yr	Prototype 10^6 BTU/yr	Prototype savings	Prototype savings
Space Heating	191.2	27.7	**86%**	**26%**
Space Cooling	285.7	54.9	**81%**	**36%**
DHW	25.8	8.7	**66%**	**3%**
Lighting*	54.2	22.3	**59%**	**5%**
Appliances + Plug	77.8	73.2	**6%**	**1%**
OA Ventilation**	1.3	2.0	**-60%**	**0%**
Total Usage	636	189	**70%**	**70%**
Site Generation	0	0		**0%**
Net Energy Use	636	189	**70%**	**70%**

Notes:

The "% of End-Use" columns show prototype energy savings in each end-use category.

The "% of Total" columns show component savings contribution to the overall savings.

Appendix D.8.7.3
Mechanical System Design

Project Report

General Project Information

Project Title:	Greencraft Ecohome
Project Date:	Wednesday, March 04, 2009

Design Data

Reference City:		Dallas, Texas
Daily Temperature Range:		Medium
Latitude:	32	Degrees
Elevation:	481	ft.
Altitude Factor:	0.983	
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:	22	0	30	72	22
Summer:	100	75	50	75	27

Check Figures

Total Building Supply CFM:	972	CFM Per Square ft.:	0.380
Square ft. of Room Area:	2,556	Square ft. Per Ton:	1,024
Volume (ft³) of Cond. Space:	25,560		

Building Loads

Total Heating Required Including Ventilation Air:	46,959	Btuh	46.959	MBH
Total Sensible Gain:	22,467	Btuh	88	%
Total Latent Gain:	2,942	Btuh	12	%
Total Cooling Required Including Ventilation Air:	25,409	Btuh	2.12	Tons (Based On Sensible + Latent)
			2.50	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.

Rhvac - Residential & Light Commercial HVAC Loads
Building Science Corporation
Westford, MA 01886

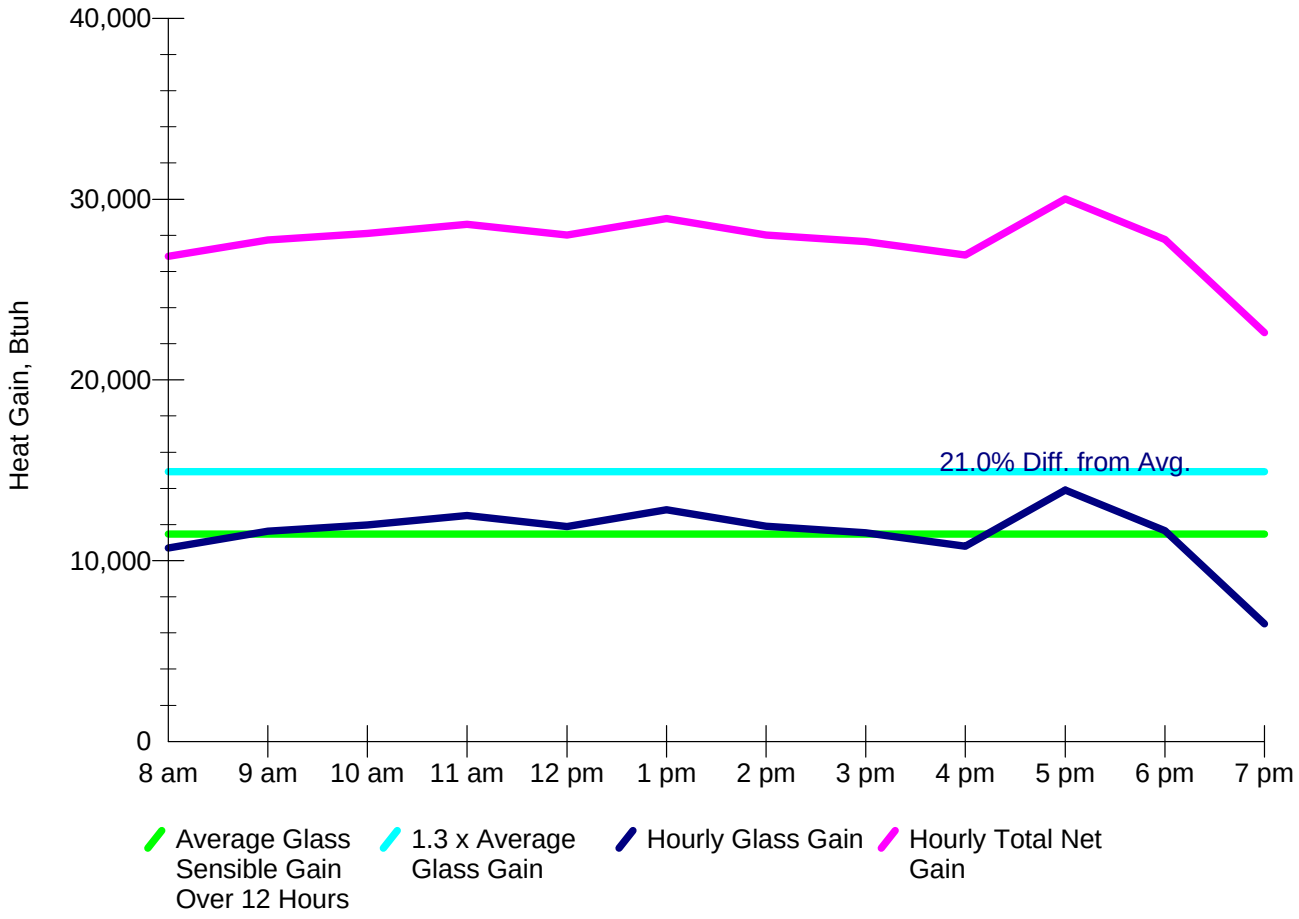
Elite Software Development, Inc.
Greencraft Ecohome

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		2.12	2.50	1,024	2,556	22,467	2,942	25,409	46,959	582	972	972	
System 1	Yes	2.12	2.50	1,024	2,556	22,467	2,942	25,409	46,959	582	972	972	14x14
Ventilation						1,459	974	2,433	2,919				
Zone 1					2,556	21,008	1,968	22,976	44,040	582	972	972	14x14
1-Whole House					2,556	21,008	1,968	22,976	44,040	582	972	972	8-7

System 1 - - Adequate Exposure Diversity Test

Test For Adequate Exposure Diversity



AED Calculation Summary

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

System is on N, E, S, W rosette.
Peak load exceeds 12-hour average load by 21.0%.
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
Pella low SG: Glazing-pella fiberglass lowe3 (Greencraft), light color drapes with medium weave with 50% coverage, u-value 0.28, SHGC 0.24	704.5	9,863	0	9,288	9,288
11P: Door-Metal - Polyurethane Core	20.4	296	0	213	213
12E-4sw: Wall-Frame, R-19 insulation in 2 x 6 stud cavity, R-4 board insulation, siding finish, wood studs	3020.1	8,305	0	3,771	3,771
R30 Icynene: Roof/Ceiling-Roof Joists Between Roof Deck and Ceiling or Foam Encapsulated Roof Joists, Custom, R30 Icynene between rafters	2556	4,729	0	3,405	3,405
22A-pl: Floor-Slab on grade, No edge insulation, no insulation below floor, any floor cover, passive, light dry soil	375	18,544	0	0	0
Subtotals for structure:		41,737	0	16,677	16,677
People:	6		1,200	1,380	2,580
Equipment:			0	1,800	1,800
Lighting:	0			0	0
Ductwork:		0	0	0	0
Infiltration: Winter CFM: 43, Summer CFM: 43		2,303	768	1,151	1,919
Ventilation: Winter CFM: 54, Summer CFM: 54		2,919	974	1,459	2,433
Total Building Load Totals:		46,959	2,942	22,467	25,409

Check Figures

Total Building Supply CFM:	972	CFM Per Square ft.:	0.380
Square ft. of Room Area:	2,556	Square ft. Per Ton:	1,024
Volume (ft³) of Cond. Space:	25,560		

Building Loads

Total Heating Required Including Ventilation Air:	46,959	Btuh	46.959	MBH
Total Sensible Gain:	22,467	Btuh	88	%
Total Latent Gain:	2,942	Btuh	12	%
Total Cooling Required Including Ventilation Air:	25,409	Btuh	2.12	Tons (Based On Sensible + Latent)
			2.50	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.

PROPOSAL

Project:	Dallas Zero Net Energy House	**Bidder:**	Building Science
Location:	Dallas, Texas	**Date:**	May 5, 2009
Engineer:	N/A	**Prepared By:**	Katherine Gilton

Bidders, we respectfully quote the below listed equipment for the above named project. Prices are valid for thirty days. Terms are net thirty days to rated accounts and per the manufacturer.

ITEM A – RESIDENTIAL SPLIT SYSTEM

1 AAON Model F1 / CB Split System

Standard Features: F1 Indoor Air Handlers:

• Direct drive forward curved supply blower with **ECM motor** provides quiet and energy efficient airflow.
• Galvanized steel construction with foil faced insulation and a removable double wall service compartment panel allow the unit to be easily cleaned and maintained.
• Sloped composite drain pan, with drain connections available on either side of the unit, resists corrosion and makes the unit easy to install.
• Factory installed TXV reduces start up time and performs more efficiently than a fixed orifice design.
• Non-ozone depleting R-410A refrigerant, which is unaffected by the refrigerant phase-out, is both environmentally friendly and maintainable.
• Filter rack with quickly replaceable 1" fiberglass air filter.

CB Series Condensing Units:

• Cabinet is constructed of painted galvanized steel that surpasses a 1000 hour salt spray test to provide the unit with corrosion protection.
• Attractive painted louvered panels protect the condenser coil from damage and debris.
• Wrap-around, single row, enhanced fin condenser coil has no additional rows to trap dirt and debris and is easier to clean than units with multirow coils.
• Two step scroll compressor includes rubber isolation mounts to minimized vibration.
• Single easily removable panel provides access to the unit service compartment.
• Crankcase heaters to prevent liquid from settling in the compressor which extends the life of the unit.
• Non-ozone depleting **R-410A refrigerant**, which is unaffected by the refrigerant phase-out, is both environmentally friendly and maintainable.
• Refrigerant circuit contains automatic low pressure and manual reset high pressure safety cut-outs, suction and liquid line Schrader valves, and a full charge of refrigerant for up to 25' of line set.

Optional Features Included:

- **Digital Scroll Compressor**
- **Robertshaw Thermostat**
- **Split System Heat Pump and Modulating Hot Gas Reheat**
- Wire Grille
- One-Time Installation Training

Items Not Included:

Warranty labor, installation, corrosion protection, control and sensor wiring, motorized dampers, disconnect, smoke detectors, refrigerant, refrigerant piping or accessories, testing and balancing, rigging, taxes or permits

AAON CP Warranty Policy:

With a residential CB and F1 or CB and AU matched split system, manufacturer's warranty shall be for a period of 10 years. Warranty shall begin on the date of the original installation, or three months after date of original shipment from the factory (as shown on the warranty certificate), whichever occurs first. The warranty shall cover material and workmanship that prove defective within the above period, under normal use and maintenance. Limited Warranty Certificate will be provided.

Notes:

Piping length must not exceed 120 ft. Piping lengths that surpass the 120 ft line length may void AAON factory warranty. **Please DO NOT use soft copper; Suction line accumulator required * reheat circuit > 50 feet length, CU-AHU use shielded Multi-strand cable (check unit instruction for # & size)**

Total net price, F.O. B Factory, FFA $5646.00

Sincerely,

Katherine E. Gilton

Applied Dehumidification, Inc
110 South Armenia Avenue
Tampa, Florida 33609
Ph: (813) 258-6609
Fax: (813) 258-6306
www.adiflorida.com

Unit Rating

203 Gum Springs Road - Longview, TX 75602 - Ph. (903) 236-4403 Fax (903) 236-4463
AAONEcat32 Ver. 4.133 (SN: 7572576-JVGLHS5J)

C B - B - 0 3 6 - 1 - B - 1 : A G 0 0 0 A 0

Tag: CU# 1

Job Information

Job Name:	*Dallas Zero Net Energy House*
Job Number:	*G-09*
Site Altitude:	*0 ft*
Refrigerant:	*R-410A*

Unit Information

Approx. Op./Ship Weights:	*237 / 237 lbs.*
Suction Temperature:	*50.00 ºF*
Ambient Temperature:	*95 ºF DB / 75 ºF WB*

Cooling Section

Cooling @ 50.00º Suction :	*37.3 MBH*
Cooling @ 35º Suction:	*28.8 MBH*
Cooling @ 40º Suction:	*31.5 MBH*
Cooling @ 45º Suction:	*34.3 MBH*
Cooling @ 50º Suction:	*37.3 MBH*

EER - ARI Listing Information

Published ARI SEER Value is based on Matching this condesing unit with a F1-036 Air Handling unit.

SEER @ ARI Conditions:	*14.8*	**EER Compressor Only @ ARI Conditions:**	*N/A*
Application EER @ Op. Conditions:	*13.7*	**Heating Season Performance Factor (HSPF):**	*8.5*

Electrical Data

Rating:	*230/1/60Hz*	Minimum Circuit Amp:	*24*
Unit FLA:	*20*	Maximum Overcurrent:	*40*

	Qty	HP	VAC	Phase	RPM	FLA	RLA
Compressor 1:	1		230	1			16.7
Condenser Fans:	1	0.33	230	1	1170	2.8	

Connection Sizes

System	Suction Line	Liquid Line
1	0.75	0.375

Unit Submittal

203 Gum Springs Road - Longview, TX 75602 - Ph. (903) 236-4403 Fax (903) 236-4463
AAONEcat32 Ver. 4.133 (SN: 7572576-JVGLHS5J)

C B - B - 0 3 6 - 1 - B - 1 : A G 0 0 0 A 0

Tag: CU# 1

Job Name: *Dallas Zero Net Energy House*
Job Number: *G-09*
Unit Submittal For:
Unit Submittal Date: *May 05, 2009*

	Base Option	Description
C	Series	Condensing Unit
B	Generation	2nd Generation
B	Revision	Second Generation
036	Unit Size	Thirty-Six MBH - Vertical Discharge
1	Voltage	208-230V/1Ø/60Hz
B	Compressors	Two Step Scroll R410A Compressor
1	Circuits	One Circuit

	Feature Option	Description
A	**1** Ambient Control	Fan Cycling (35°F Ambient)
G	**2** Refrigeration Option	Split System Heat Pump + Modulating Hot Gas Reheat
0	**3** Control	Standard - Terminal Block
0	**4** Coil	Standard - Copper tube coil with aluminum fins
0	**5** Cabinet	Standard - Louvers
A	**6** Warranty	Second To Fifth Year Extended Compressor Warranty
0	**7** Type	Standard

Unit Rating

203 Gum Springs Road - Longview, TX 75602 - Ph. (903) 236-4403 Fax (903) 236-4463
AAONEcat32 Ver. 4.133 (SN: 7572576-JVGLHS5J)

F 1 - A - 0 3 6 - 1 - M - A : A 0 0 0 F 0 0 0 A 0

Tag: AHU# 1

Job Information

Job Name:	*Dallas Zero Net Energy House*
Job Number:	*G-09*
Site Altitude:	*0 ft*
Refrigerant	*R-410A*

Unit Information

*****WEIGHT AND PERFORMANCE DO NOT INCLUDE SPA***

Approx. Op./Ship Weights:	*129 / 129 lbs.***
Supply CFM/ESP:	*700 / 0 in. wg.*
Suction:	*50.00 ºF*

Static Pressure

External:	*0.00 in. wg.*
Evaporator:	*0.08 in. wg.*
Filters Clean:	*0.11 in. wg.*
Dirt Allowance	*0.15 in. wg.*

Heating:	*0.02 in. wg.*
Total:	*0.35 in. wg.*

Cooling Section

	Gross	Net
Total Capacity:	*25.26*	*25.01 MBH*
Sensible Capacity:	*18.20*	*17.94 MBH*
Latent Capacity:	*7.07 MBH*	
Mixed Air Temp:	*80.00 ºF DB*	*67.00 ºF WB*
Entering Air Temp:	*80.00 ºF DB*	*67.00 ºF WB*
Lv Air Temp (Coil):	*55.44 ºF DB*	*54.87 ºF WB*
Lv Air Temp (Unit)	*55.77 ºF DB*	*55.01 ºF WB*
Supply Air Fan:	*1 x F1DD10-9AT @ 0.08 BHP*	
SA Fan RPM / Width:	*608 / 9.500"*	
Evaporator Coil:	*4.0 ft² / 3 Rows / 14 FPI*	
Evaporator Face Velocity:	*175.0 fpm*	

Heating Section

Heating Type:	*Electric Heat*
Heating CFM:	*700*
Total Capacity:	*17.1 MBH*
Entering Air Temp:	*60.0 ºF DB / 45.0 ºF WB*
Leaving Air Temp:	*82.6 ºF DB / 55.0 ºF WB*
Input:	*5.0 kW*
Heat Stages:	*5.0 kW*
Electric Heat FLA:	*20.8*

EER - ARI Listing Information

SEER @ ARI Conditions: *14.8* **Heating Season Performance Factor (HSPF):** *8.5*
When Matched With: *CB-036*

Electrical Data

Rating:	*230/1/60*
Unit FLA:	*4*

Minimum Circuit Amp:	*5*
Maximum Overcurrent:	*15*

Motors

	Qty	HP	VAC	Phase	RPM	FLA	RLA
Supply Fan:	1	0.5	230	1	1170	4.2	

Electric Heat

	Amps	MCA	MOP
Ciruit 1:	**21**	26	30

Unit Submittal

203 Gum Springs Road - Longview, TX 75602 - Ph. (903) 236-4403 Fax (903) 236-4463
AAONEcat32 Ver. 4.133 (SN: 7572576-JVGLHS5J)

F 1 - A - 0 3 6 - 1 - M - A : A 0 0 0 F 0 0 0 A 0

Tag: AHU# 1

Job Name: *Dallas Zero Net Energy House*
Job Number: *G-09*
Unit Submittal For:
Unit Submittal Date: *May 05, 2009*

	Base Option	Description
F	Series	Fan Coil Unit
1	Generation	First Generation
A	Revision	New
036	Unit Size	Thirty-Six MBH
1	Voltage	208-230V/1Ø/60Hz
M	Application	Multi Position (upflow or horizontal)
A	Heat	5 kW

	Feature Option	Description
A	**1** Motors	ECM 2.3 - 1/2 hp
0	**2** Filters	Standard - 1"
0	**3** Control	Standard
0	**4** Blank	Blank
F	**5** Refrigeration	Split System Heat Pump + Modulating Hot Gas Reheat
0	**6** Blank	Blank
0	**7** Blank	Blank
0	**8** Blank	Blank
A	**9** Cabinet	Textured Paint – AAON Gray
0	**10** Special	Standard

CB SERIES

CONDENSING UNITS

INSTALLATION, OPERATION & MAINTENANCE

⚠ WARNING

If the information in this manual is not followed exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

⚠ WARNING

FOR YOUR SAFETY
Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

TABLE OF CONTENTS

Owner should pay particular attention to the words: NOTE, CAUTION AND WARNING. NOTES are intended to clarify or make the installation easier. CAUTIONS are given to prevent equipment damage. WARNINGS are given to alert owner that personal injury and/or equipment damage may result if installation procedure is not handled properly.

It is the intent of AAON to provide accurate and current product information. However, in the interest of product improvement, AAON, Inc. reserves the right to change pricing, specifications, and/or design of its products without notice, obligation or liability

R57610 · Rev. B · 080702
(ACP 29023)

GENERAL DESCRIPTION

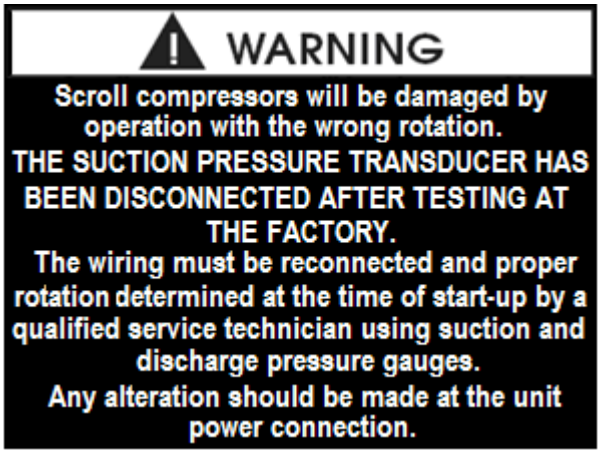
All AAON CB Series condensing units are factory assembled and wired, including a full charge of R-410A refrigerant for up to 25' of line set. Refrigeration systems are factory installed with a liquid line filter drier provided for field installation and a fully hermetic scroll compressor. Compressors are equipped with a positive pressure forced lubrication system. The air-cooled condenser coil is constructed of copper tubes with aluminum fins (copper fins optional).

Note: Systems with the modulating hot gas reheat option will require refrigerant to be field added because of the additional refrigerant components and piping associated with the system

Unpacking:
When received, remove all shipping packages and dispose of properly. Check the unit for damage that might have occurred in transit. If damage is found it should be noted on the carrier's Freight Bill. A request for inspection by carrier's agent should be made in writing at once. Check the unit nameplate to ensure that the correct model, size and voltage have been received to match the job requirements.

OWNER'S INFORMATION

Warning:
• Failure to observe the following instructions will result in premature failure of your system, and possible voiding of the product warranty.
• Never cut off the main power supply to the unit, except for complete shutdown. When power is cut off from the unit, any compressors using crankcase heaters cannot prevent refrigerant migration. This means the compressor will cool down, and liquid refrigerant may accumulate in the compressor. Since the compressor is designed to pump refrigerant gas, damage may occur when power is restored.
• Before unit operation, the main power switch must be turned **on** for at least twenty four hours for units with compressor crankcase heaters. This will give the crankcase heater time to clear any liquid accumulation out of the compressor before it is required to run.
• Always control the system from the thermostat, and never from the main power supply (except for emergency or for complete shutdown of the system).
• Improper installation, adjustment, alteration, service or maintenance can cause property damage, personal injury or loss of life. Installation and service must be performed by a qualified installer or service agency. Refer to installation instructions included in this manual.
• The compressor must be **off** for a minimum of 5 minutes after any power interruption.
• If the unit has been off for over an hour, restore power to the unit and wait two hours before turning the thermostat on.



The compressor life will be seriously shortened by reduced lubrication, and the pumping of excessive amounts of liquid oil and refrigerant.

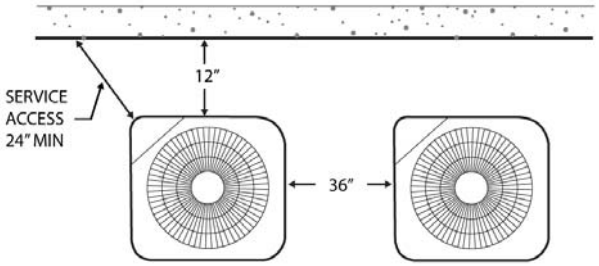
Wiring Diagrams:
• A complete set of unit specific wiring diagrams are laminated in plastic and located inside the control compartment cover.

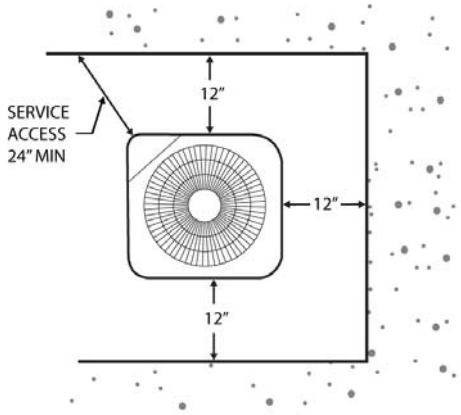
General Maintenance:
After the initial unit startup and on a periodic schedule during operation, it is necessary to perform routine service checks on the performance of the condensing unit. This includes reading and recording suction pressures and checking for normal sub-cooling and superheat. The ECM condenser fan motor is factory preprogrammed and requires no maintenance.

INSTALLATION

Lifting and Handling:
• You are encouraged to use dollies and/or carts to lift and place the unit to prevent damage to the equipment or injury to the installer.
• Care should be taken if using spreader bars, blocking, or other lifting devices to prevent any damage to the coil or the cabinet of the condensing unit.
• Before lifting unit, be sure that all shipping material has been removed from unit.
• All CB Series condensing units have channels underneath the base to provide lifting access to the underside of the equipment and allow moving and placement without physical damage.
• Hoist unit to a point directly above the pad, and lower unit into the proper place (unit may also be positioned with a dolly). When the unit is in place, remove the dolly or lifting device. Make sure the unit is properly seated and level.

Condensing Unit Placement:
• The AAON condensing unit is designed for outdoor applications and mounting at ground level or on a rooftop. It must be placed on a level and solid foundation that has been prepared to support its weight. When rooftop mounted, a steel frame must be provided that will support the unit above the roof itself. When installed at ground level, a one-piece concrete slab should be used with footings that extend below the frost line (a substantial base that will not settle).
• With ground level installation, care must be taken to protect the coil fins from damage due to vandalism or other hazards.
• The placement relative to the building air intakes and other structures must be carefully selected. Airflow to and from the condensing unit must not be restricted. Obstruction to air flow will result in decreased performance and efficiency.
• The installation position must provide at least one (1) foot of clearance from the wall for proper air flow to the coils. When units are mounted adjacent to each other, the clearance required between them is three (3) feet.
• Condensing units should not be installed in an enclosure or pit that is deeper than the height of the unit. When recessed installation is necessary, the clearance to maintain proper airflow is at least three (3) feet.





• CB-024 through CB-060 are all single circuit models with vertical air discharge. There must be no obstruction above the equipment. Do not place the unit under an overhang.
• Condenser coils and fans must be free of any obstructions in order to start and operate properly with a correct amount of airflow.
• For proper unit operation, the immediate area around condenser must remain free of debris or grass that may be drawn in and obstruct airflow in the condensing section.

• Consideration must be given to obstruction caused by snow accumulation when placing the unit.

Additional Placement Considerations:
Consider the affect of outdoor fan noise on conditioned space and any adjacent occupied space. It is recommended that the unit be placed so that discharge does not blow toward windows less than 25 feet away.

The outdoor unit should be set on a solid, level foundation - preferably a concrete slab at least 4 inches thick. The slab should be above ground level and surrounded by a graveled area for good drainage. Any slab used as a unit's foundation should not adjoin the building as it is possible that sound and vibration may be transmitted to the structure. For rooftop installation, steel or treated wood beams should be used as unit support for load distribution.

Heat pumps require special location consideration in areas of heavy snow accumulation and/or areas with prolonged continuous subfreezing temperatures. Heat pump unit bases are cutout under the outdoor coil to permit drainage of frost accumulation. The unit must be situated to permit free unobstructed drainage of the defrost water and ice. A minimum 3" clearance under the outdoor coil is required in the milder climates. In more severe weather locations, it is recommended that the unit be elevated to allow unobstructed drainage and airflow. The following elevation minimums are recommended:

Design Temperature	Suggest Minimum Elevation
+15° F and above	3”
-5° F to +17° F	8”
Below -5° F	12”

Service Clearance:
An access panel is provided to the electrical service compartment. The CB Series condensing unit service compartment must be accessible for periodic servicing of controls, safety devices, and refrigerant service/shutoff valves. At least two (2) feet of clearance on this corner of the unit is recommended for service.

Mounting Isolation:
• For roof mounted applications or anytime vibration transmission is a factor, vibration isolators may be used.

Low Ambient Operation:
• The AAON low ambient (condenser fan cycling) system is used to operate a refrigerant system down to 35°F outside air temperature. As the ambient temperature drops, the condenser becomes more effective therefore lowering the head pressure. When the head pressure gets too low there will be insufficient pressure to operate the expansion valve properly. During low ambient temperatures, it is difficult to start a system because the refrigerant will migrate to the cold part of the system (condenser) and make it difficult for refrigerant to flow.
• The AAON zero degree ambient system maintains normal head pressure during periods of low ambient by effectively reducing the heat transfer surface area, reducing capacity and increasing condensing pressure, allowing the system to operate properly. During periods with higher ambient temperatures the entire condenser is required to condense refrigerant.

Electrical:
• The single point electrical power connections are made in the electrical control compartment.
• Check the unit name plate to make sure it agrees with the power supply. Connect power to the unit according to the wiring diagram provided with the unit.
• The power and control wiring may be brought in through the utility entry. Protect the branch circuit in accordance with code requirements. If the control wires are to run inside the same conduit, 600 volt wires should be used, or as required by applicable codes. The unit must be electrically grounded in accordance with the National Electric Code.
• Units are factory wired for 230V 1 ph. 60Hz application. For 208V applications, the transformer wire taps should be changed for 208V operation.
• Power wiring is to the unit terminal block or compressor contactor. All wiring beyond this point has been done by the manufacturer and

cannot be modified without effecting the unit's agency/safety certification.

⚠ WARNING

Electric shock hazard. Can cause injury or death. Before attempting to perform any service or maintenance, turn the electrical power to unit to OFF at disconnect switch(es). Unit may have multiple power supplies.

Note: Startup technician must check motor amperage to ensure that the amperage listed on the motor nameplate is not exceeded.

Thermostat:
Units without the neutral air dehumidification feature will operate with most common thermostats. Units with the neutral air dehumidification feature must use thermostats with a normally closed (NC) dehumidification option. The following stats have been approved for usage with the dehumidification feature.

Robertshaw	**Honeywell**
9825i2	VisionPRO®IAQ

STARTUP

Pre Startup:
NOTE: Crankcase Heater Operation
All units are equipped with a crankcase heater, which should be energized at least 24 hours prior to setting the thermostat for cooling operation with the compressor.

After the installation and immediately before the startup of the condensing unit be sure that these items have been checked.

1. Verify that electrical power is available to the unit.
2. Verify that the thermostat is in the cooling mode and the "fan" switch is in the **ON** position.

While performing the Startup, use the CB Startup Form at the back of this booklet to record motor amps and any other comments.

Startup:
• Use the General Check List at the top of the Startup Form to make a last check that all the components are in place and the power supply is energized.

• CHECK COMPRESSOR FOR PROPER ROTATION BY STARTING UNIT ONLY AFTER CONNECTING PRESSURE GAUGES TO SUCTION AND DISCHARGE VALVES. THE COMPRESSOR WILL FAIL IF OPERATED IN THE WRONG DIRECTION.

• Turn cooling on – check to see that the compressor(s) is operating within tolerance.
• When unit is running, observe the system for a complete operation cycle to verify that all systems are functioning properly.

⚠ CAUTION

On three phase units the rotation must be checked on ALL MOTORS AND COMPRESSORS. SCROLL COMPRESSORS ARE DIRECTIONAL. Rotation must be checked on start-up by a qualified service technician using suction and discharge gauges. Scroll compressors will FAIL if run in the wrong direction. Condenser fan rotation should be checked and only be altered if necessary at the power connection.

• While performing the check, use the CB Startup Form to record observations of amps and refrigerant pressures.

⚠ CAUTION

Before leaving installation, a complete operating cycle should be observed to verify that all components are functioning properly.

SERVICING AND MAINTENANCE

General:
• Qualified technicians must perform routine service checks and maintenance. This includes reading and recording the condensing and suction pressures and checking for normal sub-

cooling and superheat (see *Charging Refrigerant* section).

Compressors:
Scroll compressors are fully hermetic and require no maintenance except for keeping the shell clean.

Refrigerant Filter Driers:
Each refrigerant circuit should contain a built in liquid line filter drier that is shipped loose with the unit for field installation. The unit does not include a liquid line solenoid valve. This must be field furnished and installed if required by job conditions.

Charging Refrigerant:
• The unit comes with full charge based on a 25 foot line set. Charging a system in the field must be based on determination of liquid sub-cooling and evaporator superheat. On a system with a thermostatic expansion valve liquid sub-cooling is more representative of the charge than evaporator superheat but both measurements must be taken.

IMPORTANT

The Clean Air Act of 1990 bans the intentional venting of refrigerant (CFC's and HCFC's) as of July 1, 1992. Approved methods of recovery, recycling or reclaiming must be followed. Fines and/or incarceration may be levied for non-compliance.

Before Charging:
• The unit being charged must be at or near full load conditions before adjusting the charge.
• Units equipped with hot gas reheat must have the hot gas reheat valves closed to get the proper charge.
• Units equipped with hot gas reheat must be charged with the hot gas valve closed while the unit is in cooling mode.
• After adding or removing charge the system must be allowed to stabilize, typically 10-15 minutes, before making any other adjustments.
• The type of unit and options determine the ranges for liquid sub-cooling and evaporator superheat. Refer to **TABLE 1** when determining the proper sub-cooling.
• The vertical rise of the liquid line must be known in order to adjust the sub-cooling range for proper charge.

Checking Liquid Sub-cooling:
1. Measure the temperature of the **liquid line** as it leaves the condenser coil.
2. Read the gauge pressure reading of the **liquid line** close to the point where the temperature was taken. You must use liquid line pressure as it will vary from discharge pressure due to condenser coil pressure drop.
3. Convert the pressure obtained in Step 2 to a saturated temperature using the refrigerant temperature-pressure chart at the back of this manual.
4. Subtract the measured liquid line temperature in Step 1 from the saturated temperature in Step 3 to determine the liquid sub-cooling.
5. Compare calculated sub-cooling to **TABLE 1** for the appropriate unit type and options.

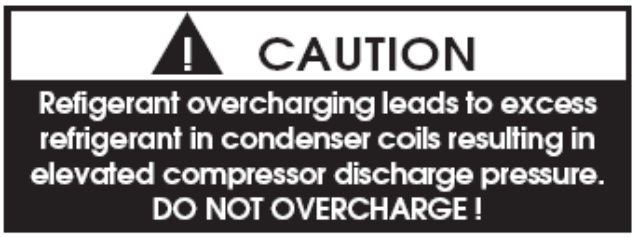
Checking Evaporator Superheat:
1. Measure the temperature of the **suction line** close to the compressor.
2. Read gauge pressure at the **suction line** close to the compressor.
3. Convert the pressure obtained in Step 2 to a saturated temperature using the appropriate refrigerant temperature-pressure chart.
4. Subtract the saturated temperature in Step 3 from the measured suction line temperature in Step 1 to determine the evaporator superheat.
5. Compare calculated superheat to **TABLE 1** for the appropriate unit type and options.

Adjusting Sub-cooling and Superheat Temperatures:
The system is **overcharged** if:
1. the sub-cooling temperature is too high **and**
2. the evaporator is fully loaded (low loads on the evaporator result in increased sub-cooling) **and**
3. the evaporator superheat is within the temperature range as shown in **TABLE 1** (high superheat results in increased sub-cooling)

TABLE 1			
	Sub-cooling (°F)	**Superheat (°F)**	**Sub-cooling W/Hot Gas Reheat (°F)**
Air-Cooled Condenser	12-18*	8-15**	15-22*

* Sub-cooling must be increased by 2°F per 20 feet of vertical liquid line rise for R- 410A
** Superheat will increase with long suction line runs.

Correct an overcharged system by reducing the amount of refrigerant in the system to lower the sub-cooling.



The system is **undercharged** if:
1. the superheat is too high **and**
2. the sub-cooling is too low

• Correct an undercharged system by adding refrigerant to the system to reduce superheat and raise sub-cooling.
• If the sub-cooling is correct and the superheat is too high, the TXV may need adjustment to correct the superheat.

Lubrication:
• All original motors and bearings are furnished with factory lubrication. They require no lubrication.

Condenser Coil:
• The air-cooled condenser rejects heat by passing outdoor air over the fin tube coils for cooling of the hot refrigerant gas from the compressors. The heated air will discharge from the unit through the axial flow fans.
• The condenser coils should be inspected yearly to ensure unrestricted airflow. If the installation has a large amount of airborne dust or other material, the condenser coils should be cleaned with a water spray in a direction opposite to airflow. Care must be taken to prevent bending of the aluminum fins on the copper tube.
• Before attempting to clean the coils; set thermostat to the "OFF" position; turn the electrical power to the unit to the "OFF" position at the disconnect switch outside by the unit. The condenser coil can be thoroughly cleaned by washing from the inside out with water and a coil cleaner. If coil is extremely dirty with clogged fins, a service professional specializing in coil cleaning should be called.

Service Information:
• If the unit will not operate correctly and a service company is required, only a company with service technicians qualified and experienced in both condensing units and air conditioning are permitted to service the systems to keep warranties in effect. If assistance is required, the service technician must contact AAON.

Note: Service technician must provide the model and serial number of the unit in all correspondence with AAON.

• Replacement parts for AAON equipment may be obtained from AAON. When ordering parts, always reference the unit model number, serial number and part number.

To order parts from the AAON parts store online go to www.aaonparts.com.

REFRIGERANT PIPING FOR THE CB SERIES

Note: This section is for information only and is not intended to provide all details required by the designer or installer of the refrigerant piping between the condensing unit and air handling equipment. AAON is not responsible for interconnecting refrigerant piping. Consult ASHRAE Handbook – Refrigeration and ASME Standards.

General:
• Piping from the condensing unit to the air handler is the responsibility of the installing contractor.
• Use only clean type "ACR" copper tubing that has been joined with high temperature brazing alloy.
• All CB series condensing units have factory furnished liquid and suction line shutoff valves.
• The pipe sizes must be selected to meet the actual installation conditions and not simply based on the connection sizes at the evaporator and/or condensing unit.
• Condensing units are provided with in-line shutoff valves on both the liquid and suction lines. These should remain closed until the system is ready for start-up after piping and vacuuming.
• Piping should conform to generally accepted practices and codes.
• Upon completion of piping connection, the interconnecting piping and air handler MUST BE evacuated to 500 microns or less; leak checked and charged with R-410A refrigerant.

Determining Refrigerant Line size:
The piping between the condenser and low side must assure:
1. Minimum pressure drop, **and**
2. Continuous oil return, **and**
3. Prevention of liquid refrigerant slugging, or carryover

• Minimizing the refrigerant line size is favorable from an economic perspective, reducing installation costs, and reducing the potential for leakage. However, as pipe diameters narrow, pressure-reducing frictional forces increase.
• Excessive suction line pressure drop causes loss of compressor capacity and increased power usage resulting in reduced system efficiency. Excessive pressure drops in the liquid line can cause the liquid refrigerant to flash, resulting in faulty expansion valve operation and improper system performance. In order to operate efficiently and cost effectively, while avoiding malfunction, refrigeration systems must be designed to minimize both cost and pressure loss.

The pipe sizes must be selected to meet the actual installation conditions, and not simply based on the connection sizes at the evaporator and/or condensing unit. Refer to TABLE RP-1 for connection size information.

Equivalent Line Length:
All line lengths discussed in this manual, unless specifically stated otherwise, are Equivalent Line Lengths. The frictional pressure drop through valves, fittings, and accessories is determined by establishing the equivalent length of straight pipe of the same diameter. **Always use equivalent line lengths when calculating pressure drop**. Special piping provisions must be taken when lines are run underground, up vertical risers, or in excessively long line runs.

Liquid line sizing:
• When sizing the liquid line, it is important to minimize the refrigerant charge to reduce installation costs and improve system reliability. This can be achieved by minimizing the liquid line diameter. However, reducing the pipe diameter will increase the velocity of the liquid refrigerant which increases the frictional pressure drop in the liquid line, and causes other undesirable effects such as noise. Maintaining the pressure in the liquid line is critical to ensuring sufficient saturation temperature, avoiding flashing upstream of the TXV, and maintaining system efficiency. Pressure losses through the liquid line due to frictional contact, installed accessories, and vertical risers are inevitable. Maintaining adequate sub-cooling at the condenser to overcome these losses is the only method to ensure that liquid refrigerant reaches the TXV.
• Liquid refrigerant traveling upwards in a riser loses head pressure. If the evaporator section is below the condenser, and the liquid line does not include risers, the gravitational force will increase the pressure of the liquid refrigerant. This will allow the refrigerant to withstand greater frictional losses without the occurrence of flashing prior to the TXV.
•A moisture-indicating sight glass may be field installed in the liquid line to indicate the occurrence of premature flashing or moisture in the line. The sight glass should not be used to

determine if the system is properly charged. **Use temperature and pressure measurements to determine liquid sub-cooling, not the sight glass.**

Liquid Line Routing:
Care should be taken with vertical risers. When the system is shut down, gravity will pull liquid down the vertical column, and back to the condenser when it is below the evaporator. This could potentially result in compressor flooding. A check valve can be installed in the liquid line where the liquid column rises above the condenser to prevent this. The liquid line is typically pitched along with the suction line, or hot gas line, in the direction of the compressor to minimize the complexity of the configuration.

Liquid Line Insulation:
When the liquid line is routed through regions where temperature losses are expected, no insulation is required, as this may provide additional sub-cooling to the refrigerant. When routing the liquid line through high temperature areas, insulation of the line is appropriate to avoid loss of sub-cooling through heat gain.

Liquid Line Guidelines:
• In order to ensure liquid at the TXV, frictional losses must not exceed available sub-cooling. A commonly used guideline to consider is a system design with pressure losses due to friction through the line not to exceed a corresponding 1-2°F change in saturation temperature.
• If the velocity of refrigerant in the liquid line is too great, it could cause excessive noise or piping erosion. The recommended maximum velocities for liquid lines are 100 fpm from the condenser to a receiver tank when used, to discourage fluid backup, and 300 fpm from receiver tank to the evaporator to minimize valve induced liquid hammer.

Liquid Line Accessories:
Liquid line shut off valves are factory installed while filter drier is shipped loose for field installation. The total length equivalent of pressure losses through valves, elbows and fittings must be considered when adding additional components in the field. It is a good practice to utilize the fewest elbows that will allow the mating units to be successfully joined.

Suction Line Sizing:
The suction line is more critical than the liquid line from a design and construction standpoint. More care must be taken to ensure that adequate velocity is achieved to return oil to the compressor at minimum loading conditions. However, reducing the piping diameter to increase the velocity at minimal load can result in excessive pressure losses, capacity reduction, and noise at full load.

Suction Line Routing:
• Pitch the suction line in the direction of flow (about 1 ft. per 100 ft of length) to maintain oil flow towards the compressor, and keep it from flooding back into the evaporator. Crankcase heaters are provided to keep any condensed refrigerant that collects in the compressor from causing damage or wear. Make sure to provide support to maintain suction line positioning, and insulate completely between the evaporator and condensing unit.
• It is important to consider part load operation when sizing suction lines. At minimum capacity, refrigerant velocity may not be adequate to return oil up the vertical riser. Decreasing the diameter of the vertical riser will increase the velocity, but also the frictional loss. A double suction riser can be applied in this situation. The double suction riser is designed to return oil at minimum load while not incurring excessive frictional losses at full load. The double suction riser consists of a small diameter riser in parallel with a larger diameter riser, and a trap at the base of the large riser. At minimum capacity, refrigerant velocity is not sufficient to carry oil up both risers, and it collects in the trap, effectively closing off the larger diameter riser, and diverting refrigerant up the small riser where velocity of the refrigerant is sufficient to maintain oil flow. At full load, the mass flow clears the trap of oil, and refrigerant is carried through both risers. The smaller diameter pipe should be sized to return oil at minimum load, while the larger diameter pipe should be sized so that flow through both pipes provides acceptable pressure drop at full load.

Suction Line Insulation:
The entire suction line should be insulated. This prevents condensation from forming on the line, and reduces any potential loss in capacity associated with heat gain placing additional load on the system.

Suction Line Guidelines:
• For proper performance, suction line velocities less than a 4000 fpm maximum are recommended. The minimum velocity required to return oil is dependent on the pipe diameter, however a general guideline of 1000 fpm minimum may be applied.
• In a fashion similar to the liquid line, a common guideline to consider is a system design with pressure losses due to friction through the line not to exceed a corresponding 1-2°F change in saturation temperature.
• At points where small pipe size can be used to provide sufficient velocity to return oil in vertical risers at part loads, greater pressure losses are incurred at full loads. This can be compensated for by over sizing the horizontal runs and vertical drop sections. This will however require additional refrigerant charge.

Suction Line Accessories:
If the job requirements specify suction accumulators, they must be separately purchased and installed.

Hot Gas Bypass Line:
• Hot Gas Bypass is available for use with DX systems that may experience low suction pressure during the operating cycle. This may be due to varying load conditions associated with VAV applications or units supplying a large percentage of outside air. The system is designed to divert refrigerant from the compressor discharge to the low-pressure side of the system in order to keep the evaporator from freezing and to maintain adequate refrigerant velocity for oil return at minimum load.
• Hot discharge gas is redirected to the evaporator inlet via an auxiliary side connector (ASC) to false load the evaporator when reduced suction pressure is sensed. **Field piping between the condensing unit and the evaporator is required.**

Hot Gas Bypass Piping Considerations for Evaporator Above Condensing Unit:
• Pitch the hot gas bypass line downward in the direction of refrigerant flow, toward the evaporator.
• When installing hot gas bypass risers, a drain leg must be provided at the lowest point in the system. The drain leg must be vertical, its diameter should be the same as the diameter of the riser, and it should be 1 foot long. Install a sight glass in the drain leg for observation. Run an oil return line, using 1/8 inch capillary tube, 10 feet in length, from the drain leg to the suction line. Connect the oil return line below the sight glass, 1 inch above the bottom of the drain leg.
• HGBP valves are adjustable. Factory HGBP valve settings will be sufficient for most applications, but may require slight adjustments for some make up air or other process cooling applications.
• Insulate the entire length of the HGBP line with a minimum 1 inch thick Armaflex insulation.

Hot Gas Bypass Piping Considerations for Evaporator Below Condensing Unit:
• The line must slope downward from the hot gas bypass valve toward the evaporator.

Hot Gas Bypass Line Guidelines:
• Choose a small size line to ensure oil return, and minimize refrigerant charge.
• Maintain velocities below a maximum of 4000 fpm. A general minimum velocity guideline to use is approximately 1000 fpm.

Hot Gas Reheat:
• The AAON modulating hot gas reheat system diverts hot discharge gas from the condenser to the air handling unit through the hot gas line. **Field piping between the condensing unit and the evaporator is required.**
• The line delivers the hot discharge gas to the reheat coil and/or the hot gas bypass valve, so it is sized as a discharge line.
• Discharge lines should be sized to ensure adequate velocity of refrigerant to ensure oil return, avoid excessive noise associated with velocities that are too high, and to minimize efficiency losses associated with friction.

• Pitch the hot gas line in the direction of flow for oil return.
• When installing hot gas reheat risers, a drip leg must be provided at the lowest point in the system. The drip leg must be vertical, its diameter should be the same as the diameter of the riser, and it should be 1 foot long. Run a drip line, using 1/8 inch capillary tube, 10 feet in length, from the drip leg to the suction line. Connect the drip line a minimum of 1-inch above the bottom of the drain leg.
• Insulate the entire length of the hot gas line with a minimum 1 inch thick Armaflex insulation.

Hot Gas Reheat Guidelines:
• Maintain velocities below a maximum of 3500 fpm. A general minimum velocity guideline is 2000 fpm.

Predetermined Line Sizes:
• To aid in line sizing and selection, AAON has predetermined line sizes for the liquid and suction lines in comfort cooling applications.
• In order to generate this information, the following cycle assumptions are made: Saturated suction temperature = 50°F, Saturated condensing temperature = 125°F, Sub-cooling = 10°F, Superheat = 15°F.
• The liquid lines have been chosen to maintain velocities between 100 and 350 fpm. The suction line diameters are selected to limit velocities to a 4000 fpm maximum, while a minimum velocity restriction is imposed by the ability to entrain oil up vertical suction risers (ASHRAE Handbook - Refrigeration).
• Acceptable pressure loss criteria are applied to each of the lines: The total equivalent length of the liquid line available is determined such that 3°F of liquid sub-cooling remain at the TXV. This includes the pressure losses in horizontal and vertical sections, accessories, elbows, etc.
• Recall that the available sub-cooling for the cycle is assumed as 10°F. To maintain at least 3°F sub-cooling as a factor of safety to avoid flashing at the TXV, we consider a maximum pressure loss equivalent to a 7°F change in saturation temperature. Pressure losses in the suction line are not to exceed 2°F.

When to use predetermined line sizing:
The line sizes presented are not the only acceptable pipe diameters, they are however appropriate for general comfort cooling applications, and satisfy common job requirements. Examine the conditions, assumptions, and constraints used in the generation of the predetermined pipe diameters to ensure that this method is applicable to a particular case. Do not assume that these line sizes are appropriate for every case. Consult ASHRAE Handbook – Refrigeration for generally accepted system practices.

How to use predetermined line sizing:
• First, read the previous section entitled *(When to use predetermined line sizing)* to decide if this method is applicable.
• Next, consult TABLE RP-1 for pipe diameters.
• Examine Figure RP-1 to determine the acceptable line dimensions associated with the pipe diameters determined in TABLE RP-1. The figure is shown as total available riser height versus total equivalent line length for the liquid line. This curve identifies a region of acceptable piping configuration when the predetermined line sizes are selected for any model in the table. A piping configuration above the curve falls outside the assumptions used to determine the line size and will result in a loss of sub-cooling, and additional pressure losses in the suction and hot gas bypass lines.
• The total equivalent line length definition includes the height of vertical rise, pressure drop through elbows and accessories, and horizontal line length, so elbows, accessories and vertical rise must be considered when determining horizontal length available from the total equivalent line length.
• Figure RP-1 is presented in terms of the liquid line, but it assumes that the line lengths for the suction and hot gas bypass are similar, as these lines will commonly be routed together to minimize the space and cost required for split system installation.

TABLE RP-1: Predetermined Line sizes for CB units with two step compressors and R-410A

Model	Connection Sizes			Predetermined Line Size			
	Liquid	Suction	Hot Gas	Liquid	Suction	HGBP*	HGRH**
CB-024	3/8 inch	3/4 inch	3/8 inch	3/8 inch	3/4 inch	3/8 inch	3/8 inch
CB-036	3/8 inch	3/4 inch	3/8 inch	3/8 inch	3/4 inch	3/8 inch	1/2 inch
CB-048	3/8 inch	7/8 inch	1/2 inch	3/8 inch	7/8 inch	1/2 inch	1/2 inch
CB-060	3/8 inch	7/8 inch	1/2 inch	1/2 inch	7/8 inch	1/2 inch	1/2 inch

* Hot Gas Bypass line
** Hot Gas Reheat line

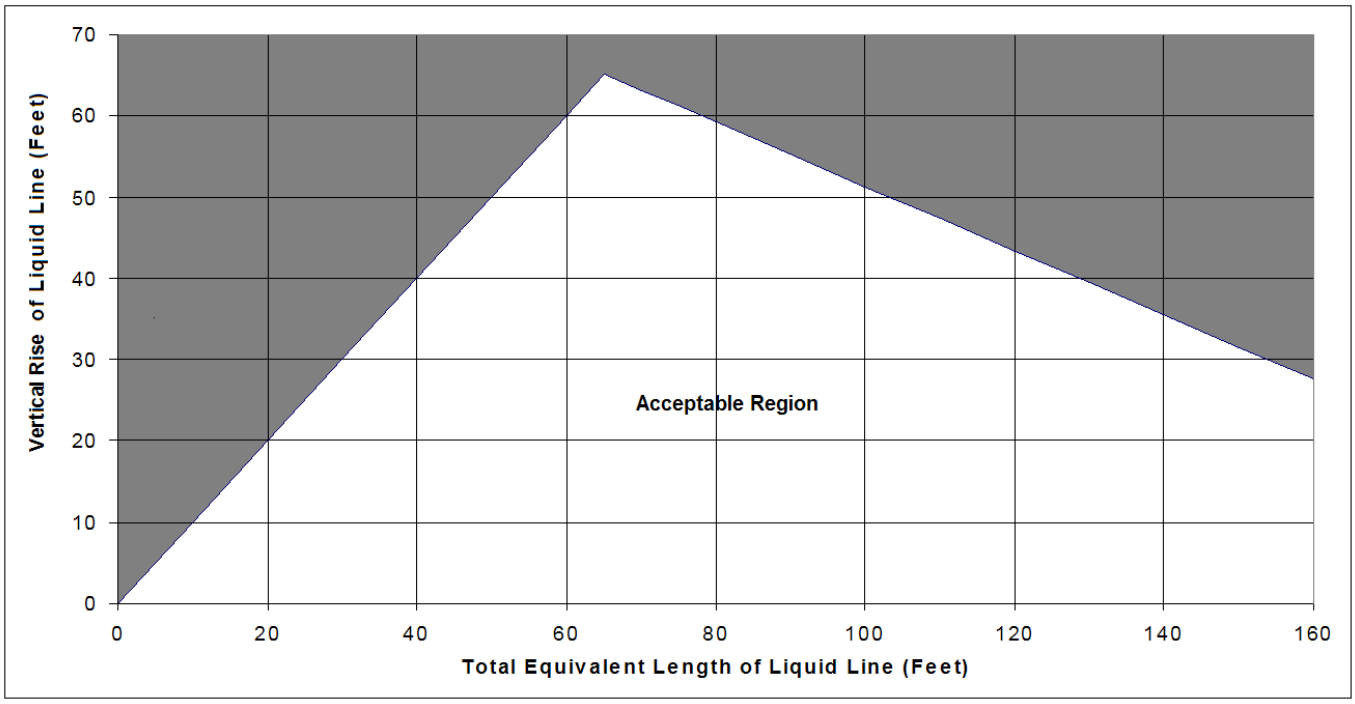


FIGURE RP-1. Riser height versus total equivalent line length for R-410A split system applications with two-step compressor CB-024 through CB-060 units. The region of acceptable riser height is the lighter area. Select the corresponding predetermined line size from TABLE RP-1 above.

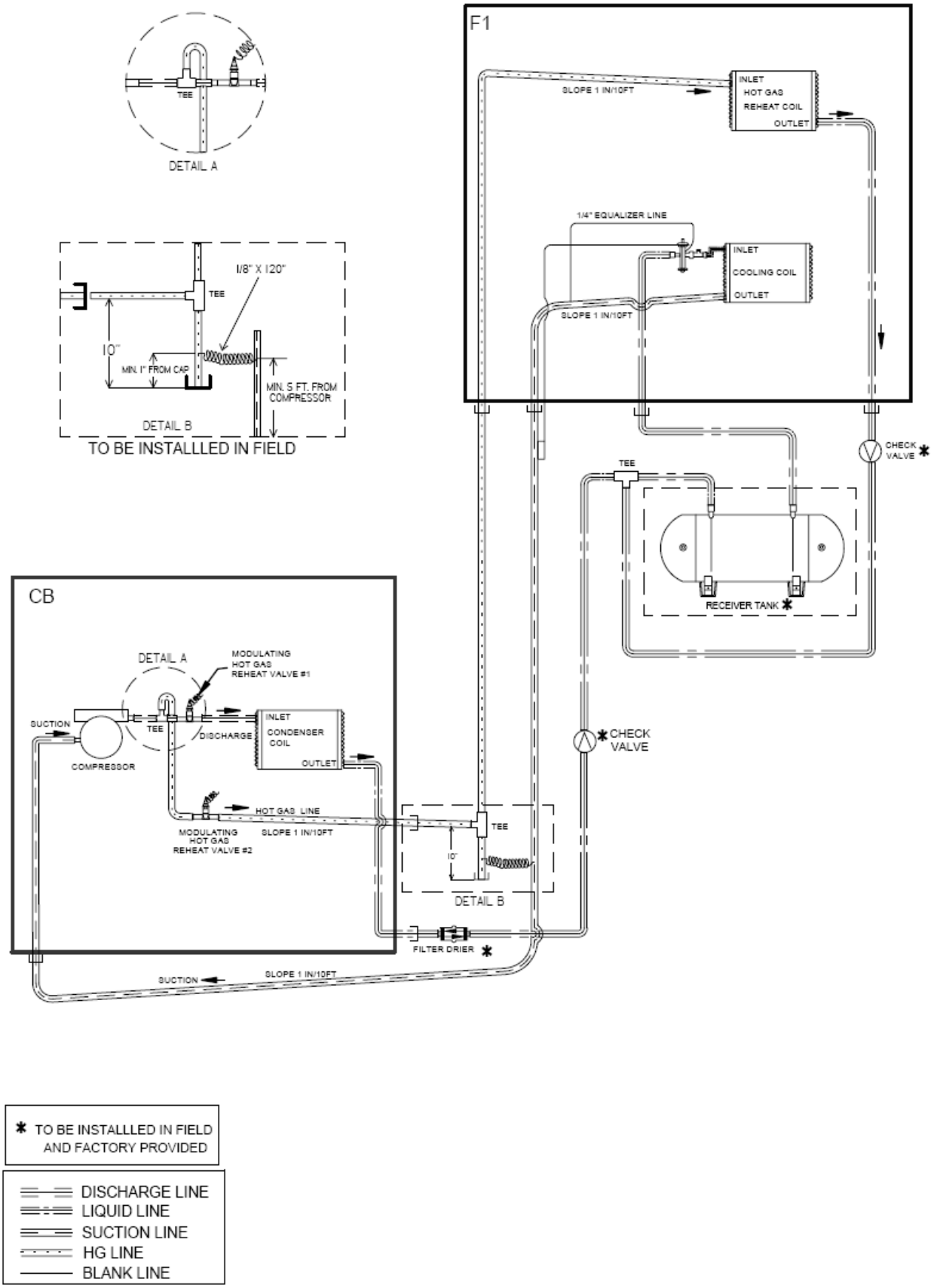


FIGURE RP-2. HOT GAS REHEAT PIPING DIAGRAM WITH AIR HANDLER ABOVE CONDENSING UNIT.

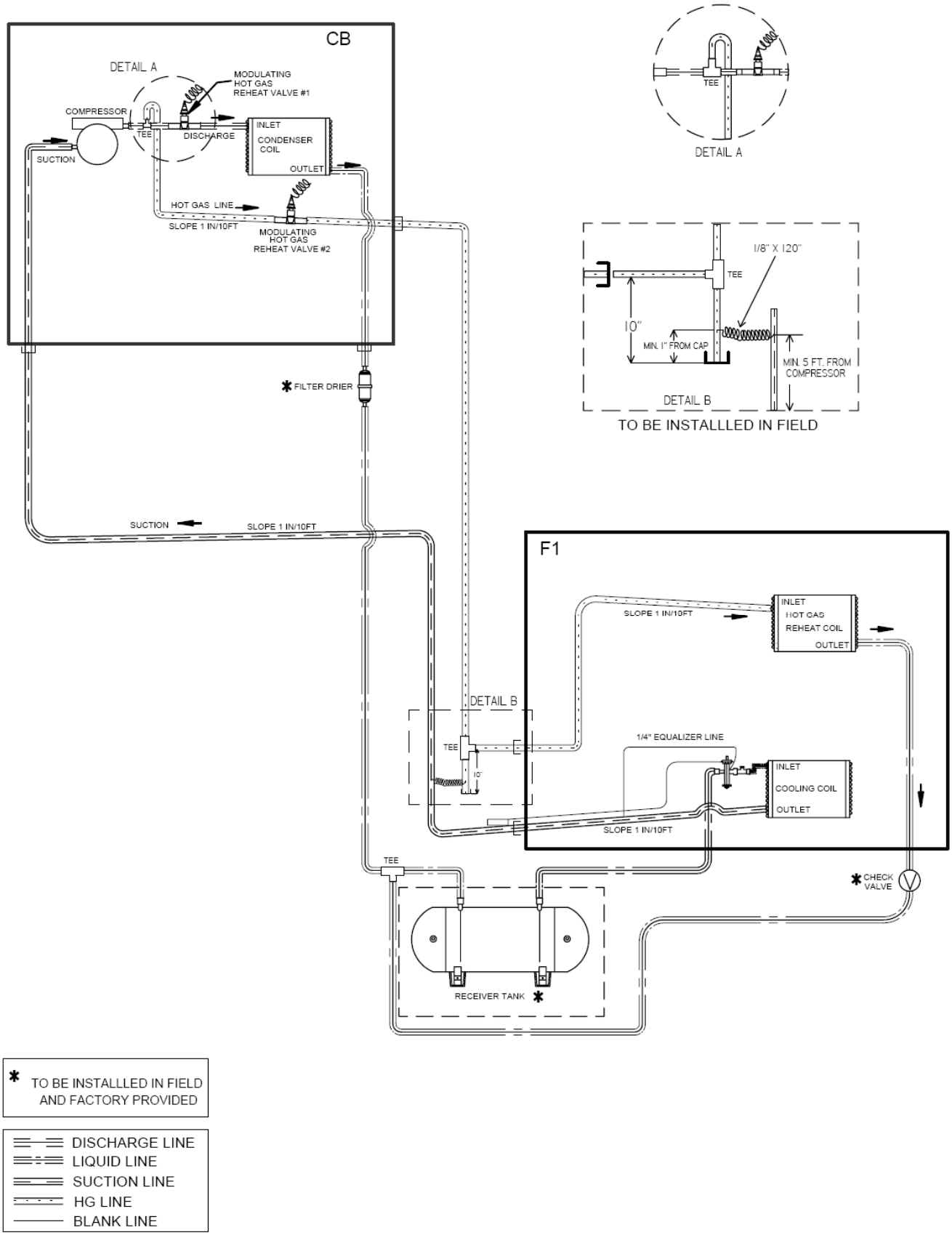


FIGURE RP-3. HOT GAS REHEAT PIPING DIAGRAM WITH AIR HANDLER BELOW CONDENSING UNIT.

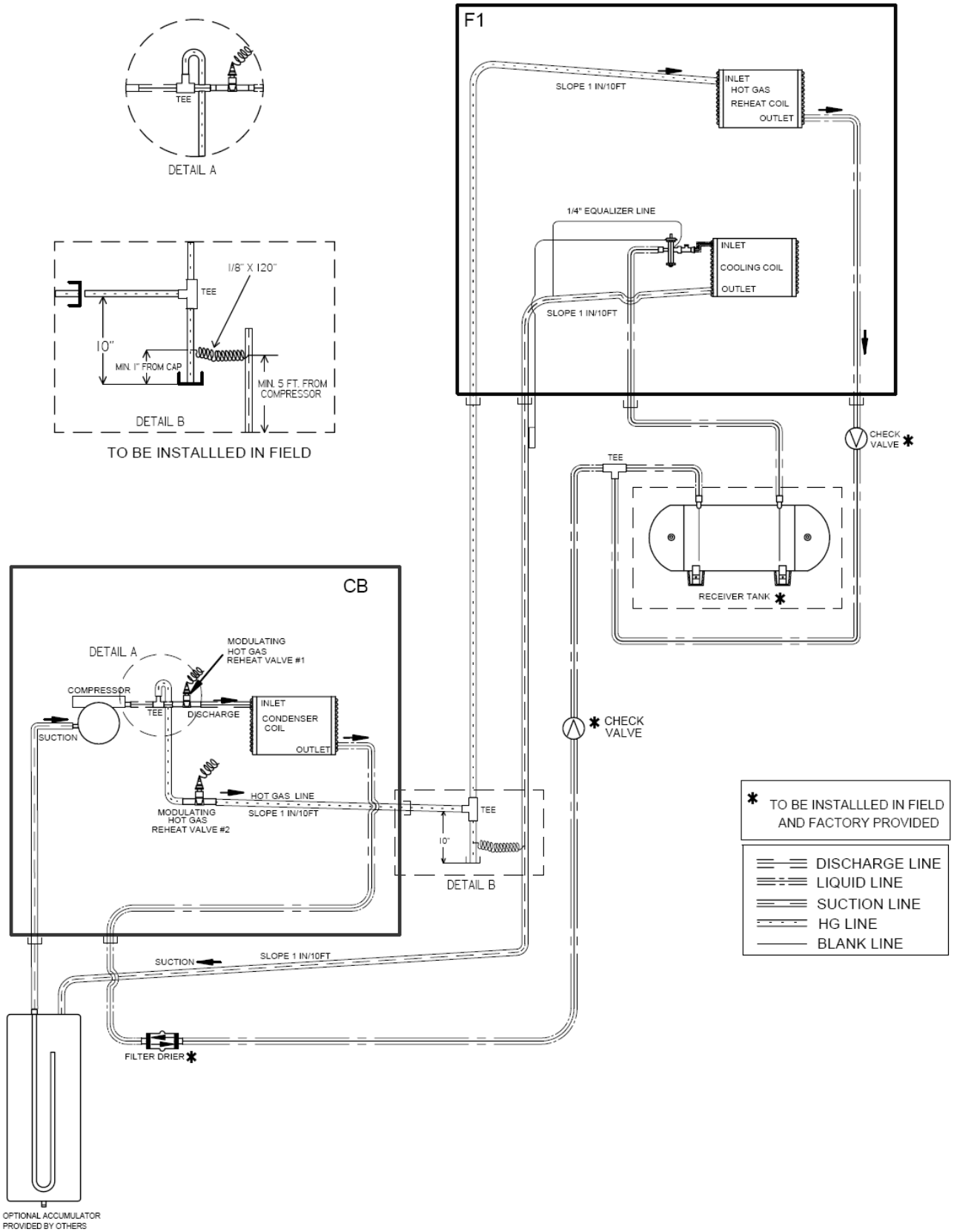


FIGURE RP-4. HOT GAS REHEAT PIPING DIAGRAM WITH AIR HANDLER ABOVE CONDENSING UNIT & OPTIONAL ACCUMULATOR.

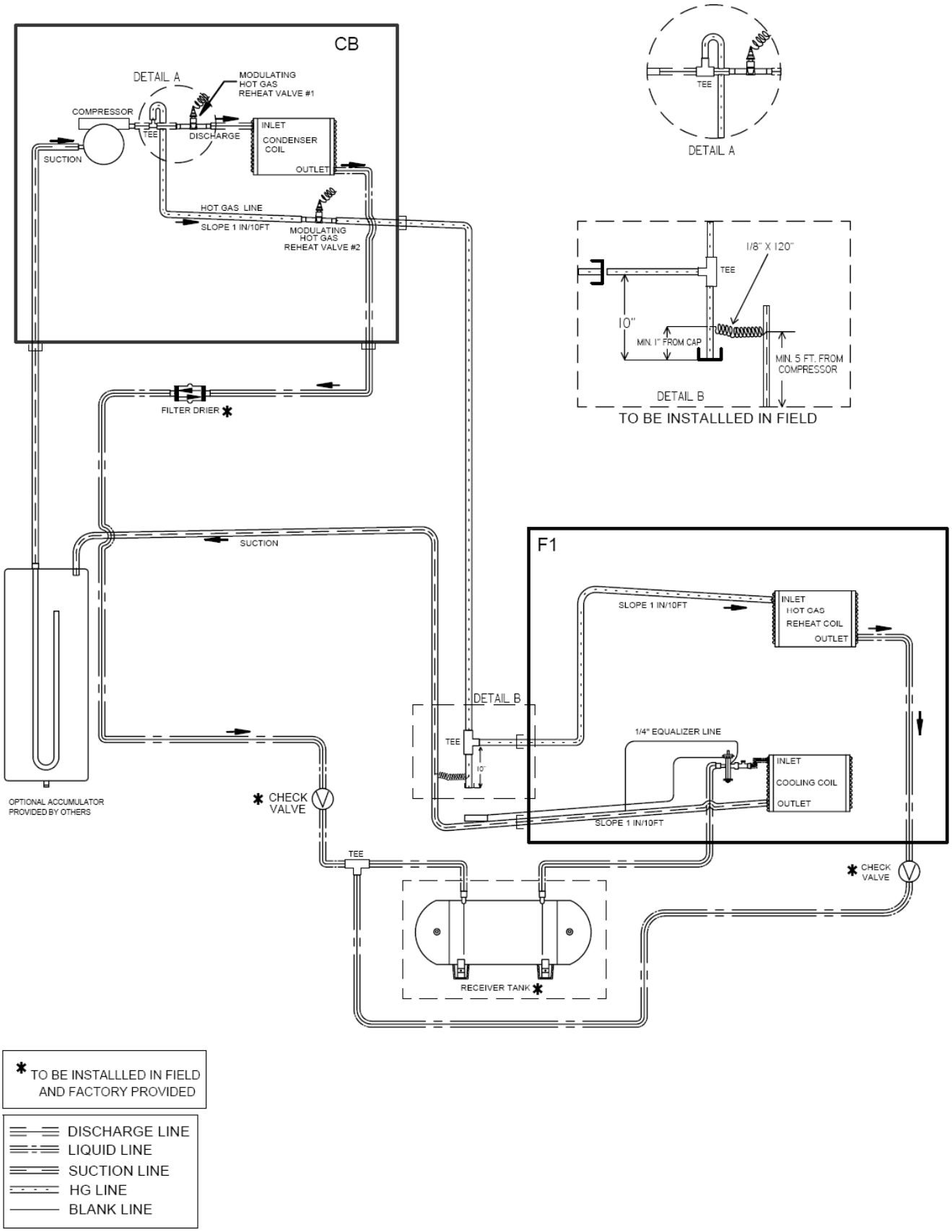


FIGURE RP-5. HOT GAS REHEAT PIPING DIAGRAM WITH AIR HANDLER BELOW CONDENSING UNIT & OPTIONAL ACCUMULATOR.

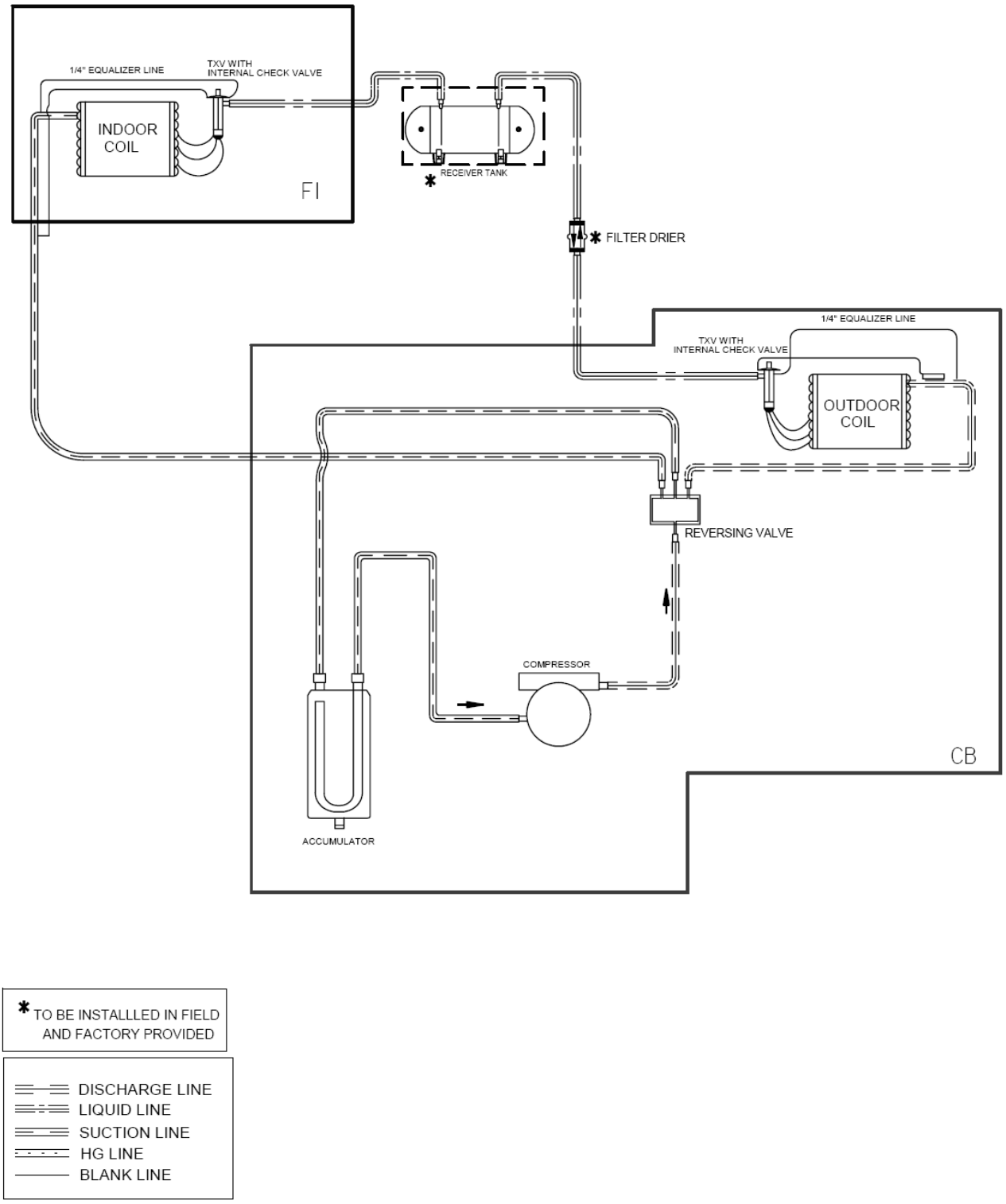


FIGURE RP-6. HEAT PUMP PIPING WITH INDOOR UNIT ABOVE OUTDOOR UNIT

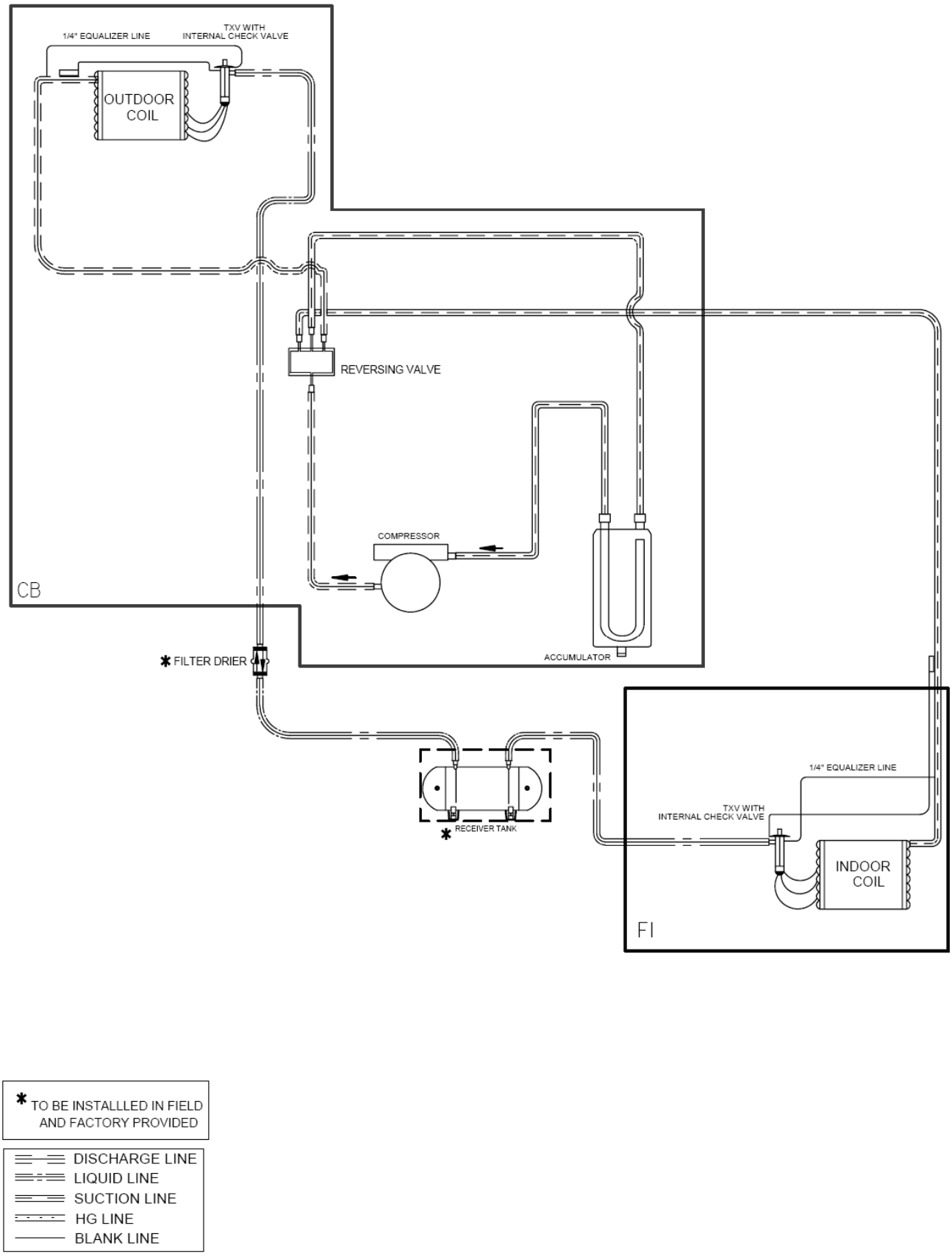


FIGURE RP-7. HEAT PUMP PIPING WITH OUTDOOR UNIT ABOVE INDOOR UNIT

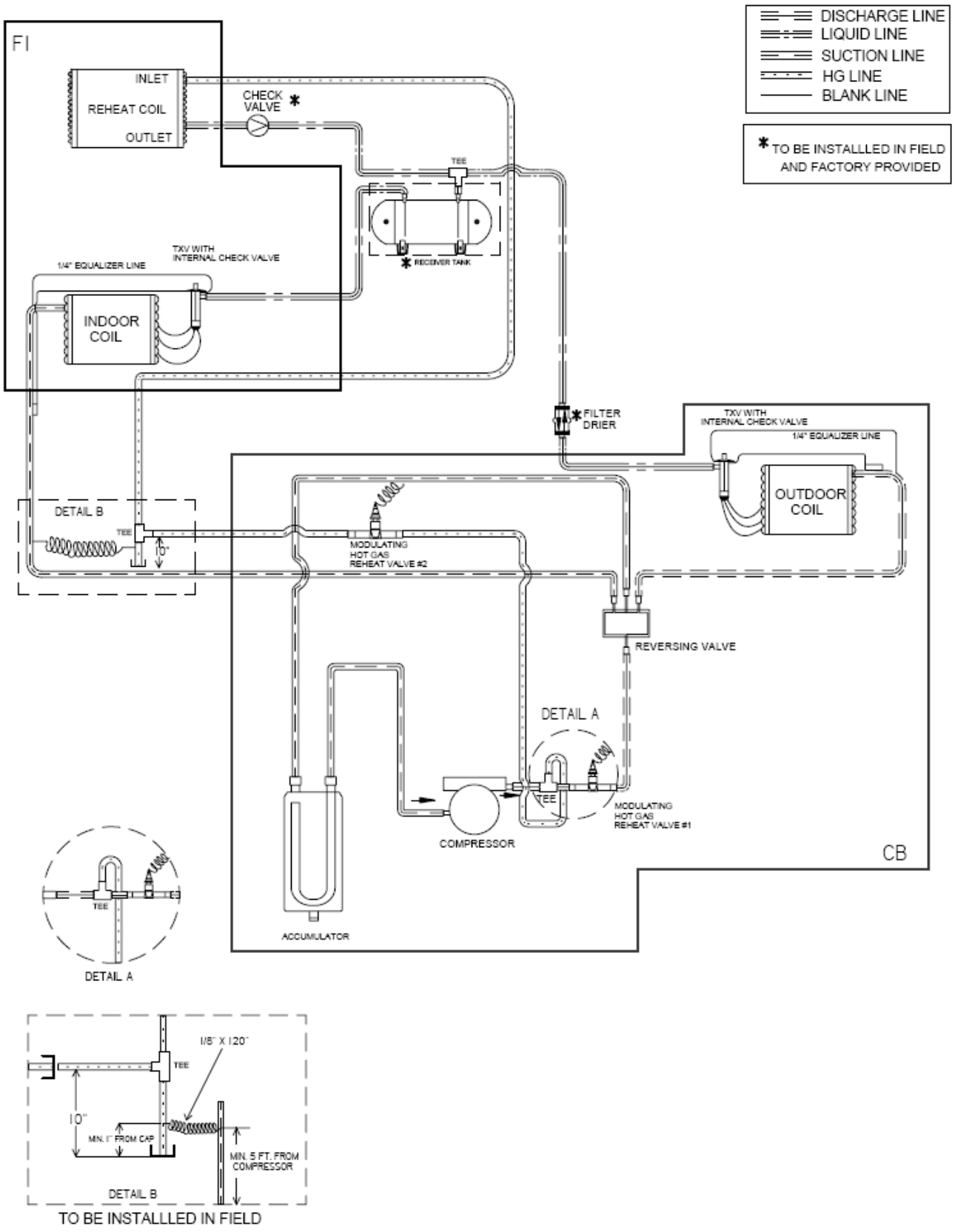


FIGURE RP-8. HEAT PUMP PIPING WITH REHEAT & INDOOR UNIT ABOVE OUTDOOR UNIT

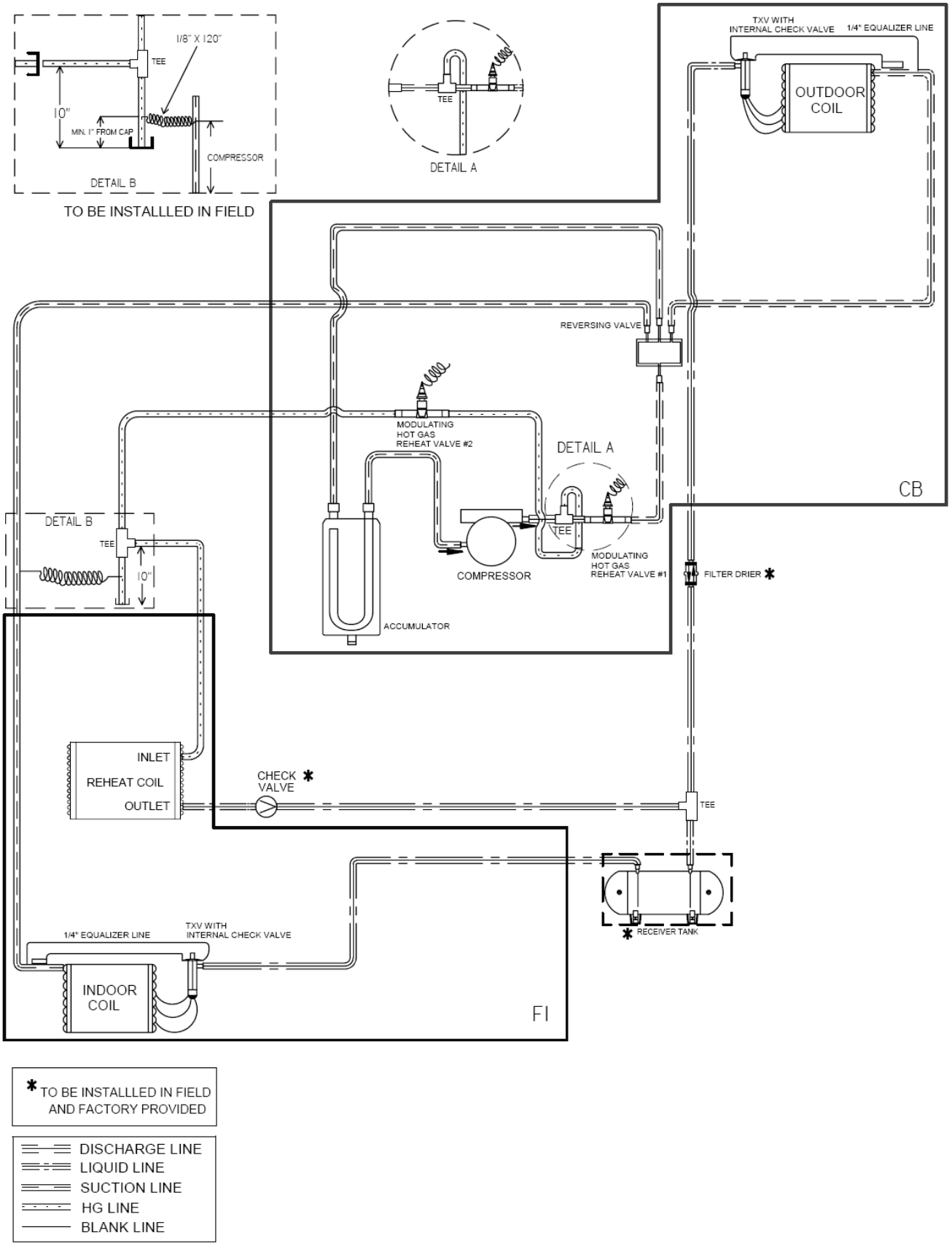


FIGURE RP-9. HEAT PUMP PIPING WITH REHEAT & OUTDOOR UNIT ABOVE INDOOR UNIT

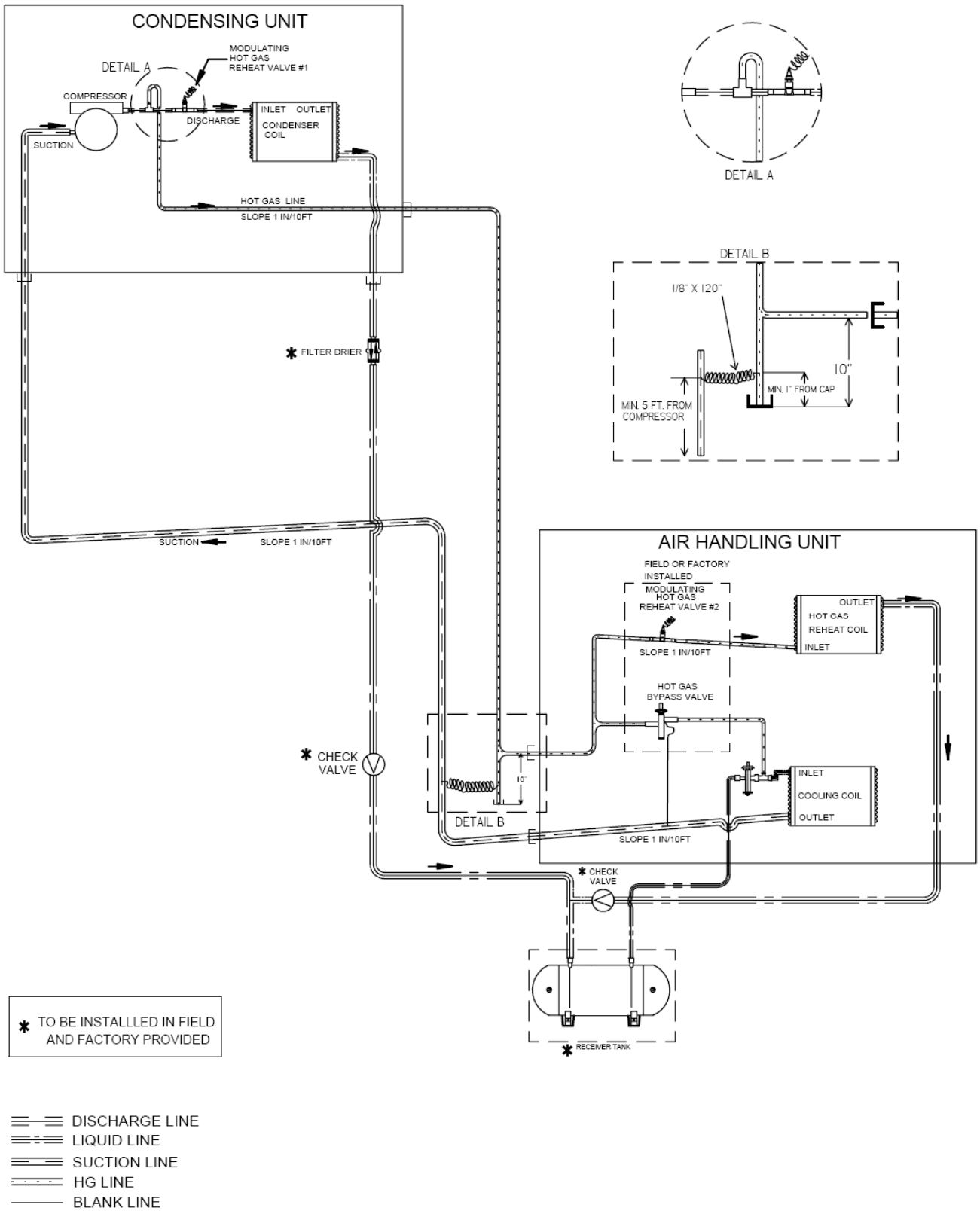


FIGURE RP-10. HOT GAS REHEAT PIPING DIAGRAM WITH HOT GAS BYPASS & AIR HANDLER BELOW CONDENSING UNIT.

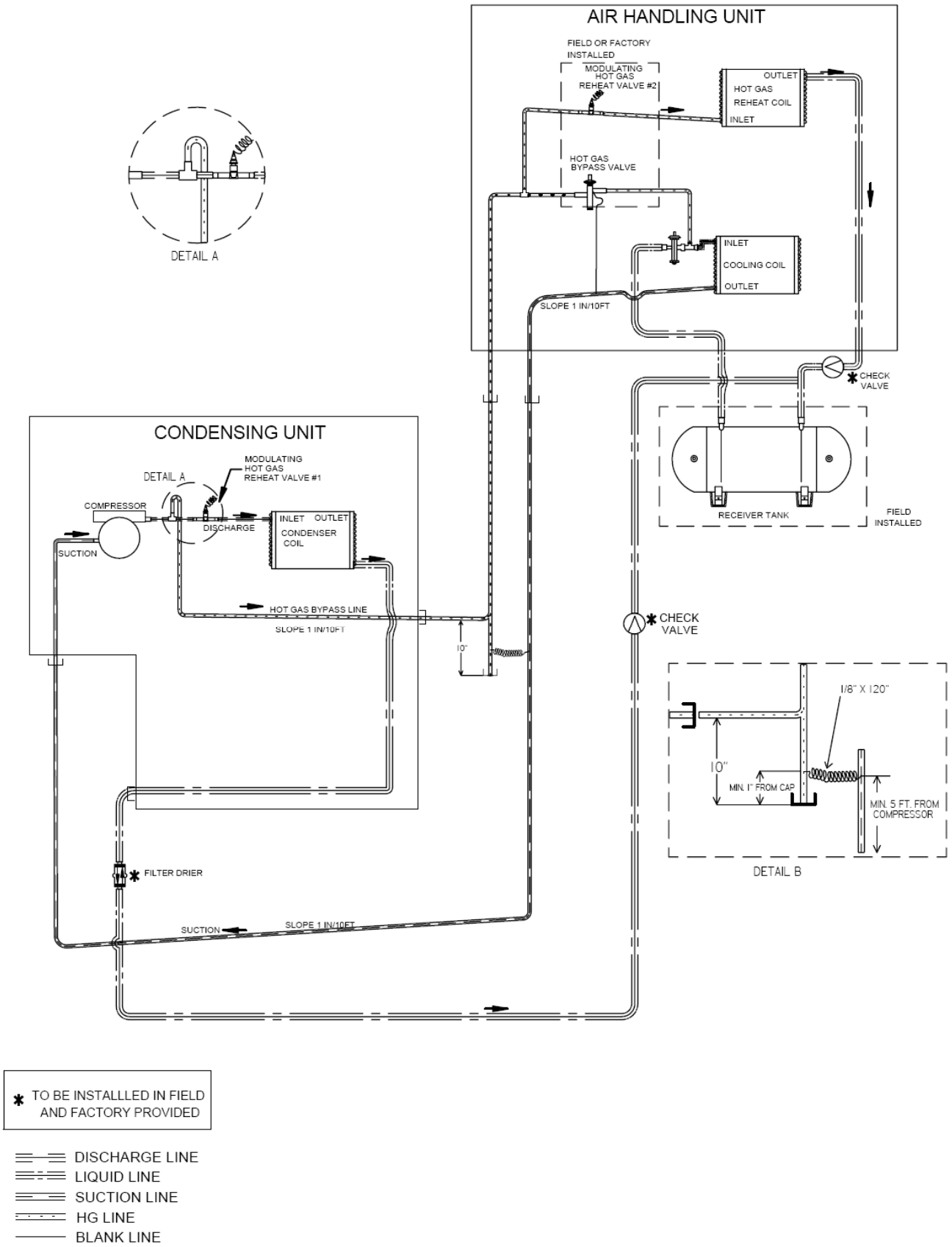


FIGURE RP-11. HOT GAS REHEAT PIPING DIAGRAM WITH HOT GAS BYPASS & AIR HANDLER ABOVE CONDENSING UNIT.

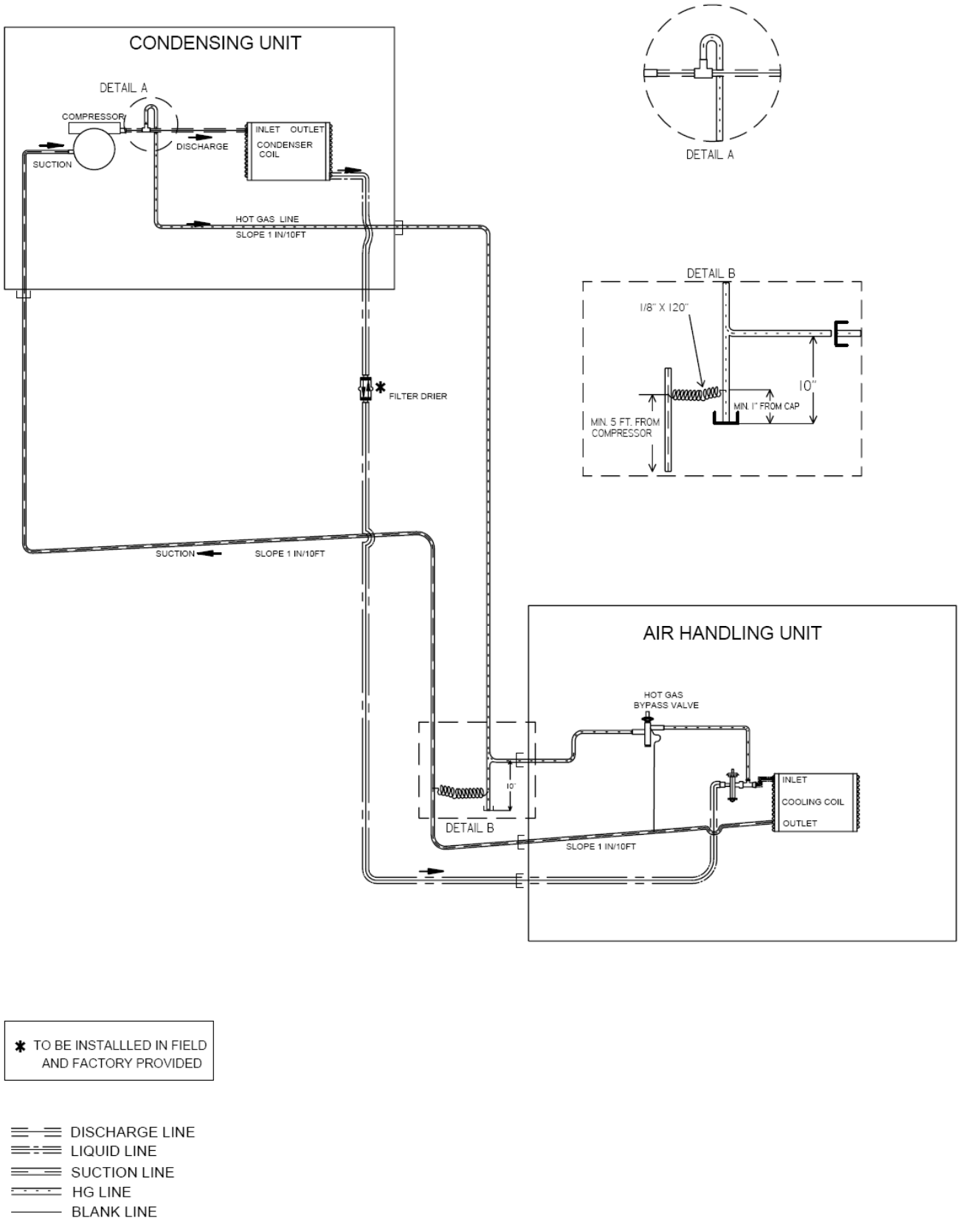


FIGURE RP-12. HOT GAS BYPASS PIPING DIAGRAM WITH AIR HANDLER BELOW CONDENSING UNIT.

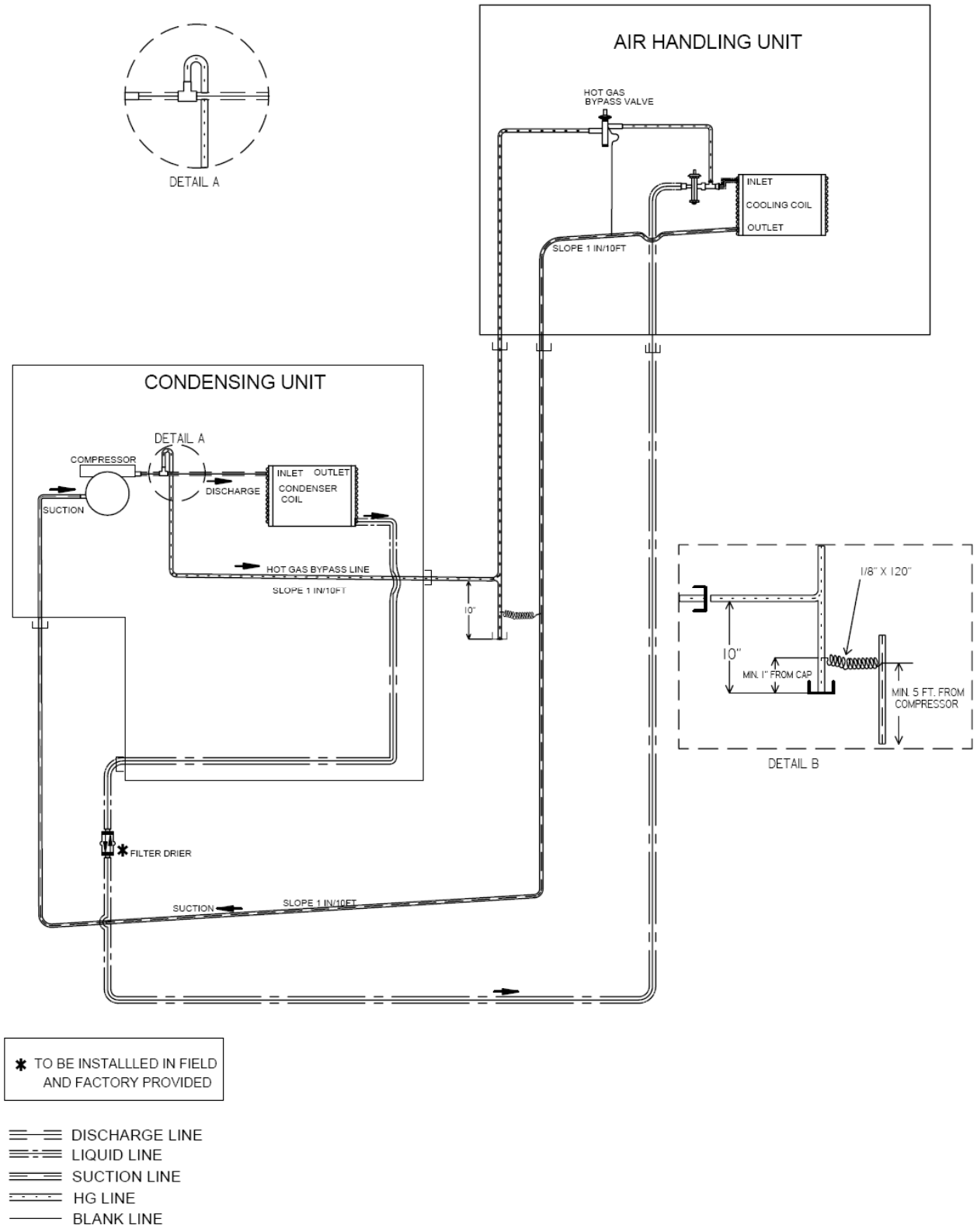


FIGURE RP-13. HOT GAS BYPASS PIPING DIAGRAM WITH AIR HANDLER ABOVE CONDENSING UNIT.

CB STARTUP FORM

DATE:_____

JOB NAME:_____

ADDRESS:_____ MODEL No:_____

CITY, STATE:_____ SERIAL No:_____

START-UP CONTRACTOR:_____ TAG:_____

PRE STARTUP CHECKLIST

Installing contractor shall verify the following items (cross out items that do not apply).

1. Is there any visible shipping damage?_____ Yes ☐ No ☐
2. Is the unit installation level?_____ Yes ☐ No ☐
3. Are the unit clearances adequate for service and operation?_____ Yes ☐ No ☐
4. Do all access panels removable freely?_____ Yes ☐ No ☐
5. Have all shipping braces been removed?_____ Yes ☐ No ☐
6. Have all electrical connections been tested for tightness?_____ Yes ☐ No ☐
7. Does the electrical service correspond to the unit nameplate?_____ Yes ☐ No ☐
8. Has the over current protection been installed to match unit nameplate requirement?_____ Yes ☐ No ☐
9. Have all set screws on fans (if applicable) been tightened?_____ Yes ☐ No ☐
10. Does condenser fan rotate freely?_____ Yes ☐ No ☐

COOLING TEST

COMPRESSORS					CRANKCASE HEATER AMPS
NUMBER	MODEL #	AMPS L1	L2	L3	
1					

AMBIENT TEMPERATURE

AMBIENT DRY BULB TEMP_____°F AMBIENT WET BULB TEMP_____°F

REFRIGERATION SYSTEM #1

	PRESSURE	SATURATED TEMPERATURE	LINE TEMPERATURE	SUB-COOLING	SUPERHEAT
DISCHARGE					
SUCTION					
LIQUID					

CONDENSER FAN AMPS

ALIGNMENT_____☐ CHECK ROTATION_____☐ NAMEPLATE AMPS_____☐

NUMBER	HP	L1	L2	L3
1				

NOTES:

R-410A Saturation Pressure/Temperature Chart

(°F)	*PSIG*	*(°F)*	*PSIG*	*(°F)*	*PSIG*	*(°F)*	*PSIG*	*(°F)*	*PSIG*
20	78.3	**50**	142.2	**80**	234.9	**110**	364.1	**140**	540.1
21	80	**51**	144.8	**81**	238.6	**111**	369.1	**141**	547
22	81.8	**52**	147.4	**82**	242.3	**112**	374.2	**142**	553.9
23	83.6	**53**	150.1	**83**	246	**113**	379.4	**143**	560.9
24	85.4	**54**	152.8	**84**	249.8	**114**	384.6	**144**	567.9
25	87.2	**55**	155.5	**85**	253.7	**115**	389.9	**145**	575.1
26	89.1	**56**	158.2	**86**	257.5	**116**	395.2	**146**	582.3
27	91	**57**	161	**87**	261.4	**117**	400.5	**147**	589.6
28	92.9	**58**	163.8	**88**	265.4	**118**	405.9	**148**	596.9
29	94.9	**59**	166.7	**89**	269.4	**119**	411.4	**149**	604.4
30	96.8	**60**	169.6	**90**	273.5	**120**	416.9	**150**	611.9
31	98.8	**61**	172.5	**91**	277.6	**121**	422.5		
32	100.9	**62**	175.4	**92**	281.7	**122**	428.2		
33	102.9	**63**	178.4	**93**	285.9	**123**	433.9		
34	105	**64**	181.5	**94**	290.1	**124**	439.6		
35	107.1	**65**	184.5	**95**	294.4	**125**	445.4		
36	109.2	**66**	187.6	**96**	298.7	**126**	451.3		
37	111.4	**67**	190.7	**97**	303	**127**	457.3		
38	113.6	**68**	193.9	**98**	307.5	**128**	463.2		
39	115.8	**69**	197.1	**99**	311.9	**129**	469.3		
40	118.1	**70**	200.4	**100**	316.4	**130**	475.4		
41	120.3	**71**	203.6	**101**	321	**131**	481.6		
42	122.7	**72**	207	**102**	325.6	**132**	487.8		
43	125	**73**	210.3	**103**	330.2	**133**	494.1		
44	127.4	**74**	213.7	**104**	334.9	**134**	500.5		
45	129.8	**75**	217.1	**105**	339.6	**135**	506.9		
46	132.2	**76**	220.6	**106**	344.4	**136**	513.4		
47	134.7	**77**	224.1	**107**	349.3	**137**	520		
48	137.2	**78**	227.7	**108**	354.2	**138**	526.6		
49	139.7	**79**	231.3	**109**	359.1	**139**	533.3		

CB SERIES
CONDENSING UNITS

INSTALLATION, OPERATION
&
MAINTENANCE

R57610 · Rev. B · 080702
(ACP 29023)

AAON
2425 South Yukon Ave.
Tulsa, OK 74107-2728
Phone: (918) 583-2266
Fax: (918) 583-6094
www.aaon.com

AAON

CB Series

CONDENSING UNITS

ENVIRONMENTALLY FRIENDLY REFRIGERANT
AAON
410A

Features:

- 2-5 Ton / 24-60 MBH Condensing Units
- High Efficiency, Two Step, R-410A Scroll Compressor
- Ultra-High Efficiency ECM Condenser Fan Motor
- Modulating Humidity Control; Controls Humidity Independent from Temperature
- Labeled Components for Quick and Easy Installation
- Labeled Controls Components with Color-Coded Wiring that Matches the Unit Wiring Diagram Included in the Controls Compartment
- Matching F1 Series and H2/V2 Series Air Handlers Available for a Complete Split System Solution
- ETL and ARI Listed
- Heat Pump or Cooling Only Operation

Application Flexibility
Minimizes Installation Time and Reduces Cost

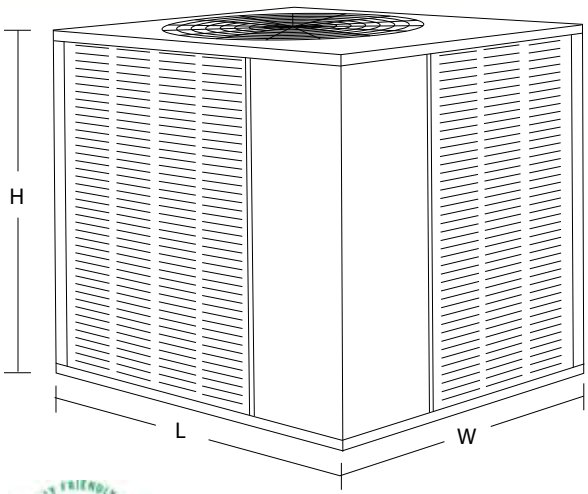
- *High Efficiency Heat Pump Option*
- *Modulating Dehumidification*
- *Part Load Capability*
- *Quiet Operation*

CB Series Condensing Units

AAON® CB Series condensing units, for residential and commercial application, boast the same benefits that customers have come to expect from other AAON® equipment: serviceability, quiet operation, reliability, high efficiency, durable construction, and a number of premier options which provide the equipment with the flexibility to suit a wide variety of job requirements.

Superior Features

- Cabinet is constructed of painted galvanized steel that surpasses a 1000 hour salt spray test to provide the unit with corrosion protection.
- Attractive painted louvered panels protect the condenser coil from damage and debris.
- Wrap-around, single row, enhanced fin condenser coil has no additional rows to trap dirt and debris and is easier to clean than units with multirow coils.
- Two step scroll compressor includes rubber isolation mounts to minimized vibration.
- Single easily removable panel provides access to the unit service compartment.
- Crankcase heaters to prevent liquid from settling in the compressor which extends the life of the unit.
- Non-ozone depleting R-410A refrigerant, which is unaffected by the refrigerant phase-out, is both environmentally friendly and maintainable.
- Refrigerant circuit contains automatic low pressure and manual reset high pressure safety cut-outs, suction and liquid line Schrader valves, and a full charge of refrigerant for up to 25' of line set.



CB Model	Size (Tons)	Width	Height	Length
024	2	31	39	36
036	3			
048	4	36	43	37
060	5			

All dimensions are in inches. For use with R-410A only.

Quiet, Economical Performance

Premier Options

- Modulating hot gas reheat for energy efficient and comfortable dehumidification.
- External hot gas bypass provides freeze protection for the matching air handler's evaporator coil during light load conditions.
- Wired grille condenser coil guard option is available if protection provided by the louvered panels is not required.
- High density foam compressor sound suppression blanket to reduce radiated noise.
- Polymer e-coated or copper finned coils to extent the life of the coils and protect them in corrosive environments.
- Low ambient fan cycling option to allow cooling operation down to 35°F.
- 24V control circuit transformer option to prevent exceeding the capacity of the air handler's control circuit transformer.
- Optional commercial 5 year compressor warranty.
- Standard 5 and optional 10 year residential parts warranties, when matched with an F1 Series air handler.

Matching CB and F1, Air Conditioner Performance			
Condensing Unit	Air Handler	Nominal Capacity	SEER
CB-024	F1-024	24 MBH / 2 Tons	17.2
CB-036	F1-036	36 MBH / 3 Tons	15.5
CB-048	F1-048	48 MBH / 4 Tons	15.6
CB-060	F1-060	60 MBH / 5 Tons	14.6

Matching CB and F1, Heat Pump Performance				
Condensing Unit	Air Handler	Nominal Capacity	SEER	HSPF
CB-024	F1-024	24 MBH / 2 Tons	16.3	8.5
CB-036	F1-036	36 MBH / 3 Tons	14.8	8.5
CB-048	F1-048	48 MBH / 4 Tons	14.7	8.7
CB-060	F1-060	60 MBH / 5 Tons	14.4	8.3

Split System Heat Pump

Energy efficient heating option that allows a split system to be able to provide on demand cooling and heating with the refrigeration circuit. Option is available as a matched split system with a CB Series condensing unit and matching AAON heat pump air handler.

Split System Modulating Humidity Control

This premier option provides energy efficient dehumidification, even at low sensible heat loads, with modulating valves that reduce temperature swings. During the dehumidification mode of operation the system uses the valves to control the amount of reheat provided by the factory installed reheat coil, thus dehumidifying the air while at the same time supplying comfortable, room temperature air. Moisture related indoor air quality issues, such as mold growth, condensation, and structural deterioration, are minimized, or eliminated, by reducing the space humidity while enhancing occupant comfort.

Energy Efficient at Full and Part Load

The CB Series condensing unit features standard a two step compressor which provides two stages of capacity, 67% and 100%, for energy efficient part and full load operation. In addition, a factory installed and configured ultra-high efficiency ECM condenser fan motor is set up for two speed operation to match with the capacity steps of the compressor.

AAON Environmentally Friendly HVAC Product Family

Customer Commitment – AAON encourages environmentally responsible design by incorporating many energy saving features into our superior heating and cooling products. In addition to energy efficiency, AAON also offers environmentally friendly R-410A refrigerant capability in all our cooling and heat pump equipment. As countries throughout the world phase out CFC and HCFC refrigerants, R-410A is becoming the global standard and AAON is leading the way!

Rooftop Units


2 - 5 Tons


2 - 30 Tons


26 - 70 Tons


45 - 230 Tons

Condensing Units


2 - 5 Tons

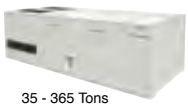

2 - 5 Tons


6 - 60 Tons


45 - 230 Tons

Air-Cooled or Evaporative-Cooled Chiller


35 - 365 Tons


35 - 365 Tons

Boiler


500 - 6,000 MBH

Outdoor Air Handling Units


800 - 2,000 CFM


800 - 12,000 CFM


10,400 - 28,000 CFM


18,000 - 68,000 CFM

Indoor Air Handling Units


1,000 - 16,000 CFM


16,000 - 51,500 CFM


800 - 10,000 CFM


800 - 2,000 CFM

Custom Indoor or Outdoor Air Handling Units


Direct Fired
1,500 - 100,000+ CFM


1,500 - 218,000 CFM • Indirect Fired


1,500 - 120,000+ CFM

CB • R66640 • 080430

CB/CC Series
Condensing Units
Engineering Catalog

Table of Contents

R59070 · Rev. A · 080312
(ACP 29222)

Index of Tables and Figures

Tables:

Figures:

Features and Options

AAON® CB/CC Series condensing units, for residential and commercial applications, boast the same benefits that customers have come to expect from other AAON equipment: serviceability, quiet operation, reliability, high efficiency, durable construction, and a number of premier options which provide the equipment with the flexibility to suit a wide variety of job requirements.

Non-ozone depleting R-410A refrigerant is standard on the both the CB and CC Series condensing units, making them both environmentally friendly and maintainable.

Convenience and Serviceability
Each CB/CC Series condensing unit is delivered to the jobsite ready for connection, charging, and startup. All components are labeled and connected with color-coded wiring to match the included color-coded wiring diagram. The CC Series features standard hinged controls and compressor cabinet access doors and coil and fan access doors with lockable handles, while the CB Series has easily removable paneling that provides convenient access to the unit controls. The CB Series upright coil design featuring AAON single row, enhanced fin, bent coil construction and CC Series upright coil design featuring multiple row, enhanced fin, unbent slab coil construction maximizes cleanability and long lasting performance.

Reliability
Cabinet construction, including standard louvered coil protection, is entirely G-90 galvanized steel to provide strength and durability. Corrosion resistant external paint surpasses 1000 hour salt spray testing, per ASTM B 117-95 requirements. AAON integrates the latest in scroll compressor technology into all of its products for greater operational reliability than comparable reciprocating compressors.

Quiet Operation
In addition to being dependable, the hermetic scroll compressors included in each CB/CC Series condensing unit offer quieter operation than comparable reciprocating compressors. Noise reduction is enhanced by vibration minimizing rubber isolation mounts included standard. Compressor sound blanket option is available on the CB Series for maximum compressor sound attenuation.

Efficiency
While being both reliable and quiet, scroll compressors also reduce frictional losses and improve system efficiencies. The CB Series condensing unit, with standard two step scroll compressor, matches with the AAON F1 Series indoor air handler that employs the latest in ultra-high efficiency ECM motor technology to dramatically increase SEER ratings.

Modulating Hot Gas Reheat Option - Humidity control option that minimizes temperature swings during dehumidification. Moisture related indoor air quality issues are minimized by reducing space humidity without sacrificing occupant comfort.

Split System Heat Pump Option - Energy efficient heating option that allows split system to be able to provide on demand heating and cooling with the refrigeration circuit. Option is available as a matched split system with a CB Series condensing unit and an F1 Series air handler.

Low Ambient Options - Head pressure control condenser fan cycling options allow cooling operation down to 35°F ambient temperature.

CB Base Model and Features Description

Model/Feature Number

C	B	-	A	-	0	6	0	-	3	-	B	-	1	:	A	D	0	0	0	A	0
1	2		3		4	5	6		7		8		9		10	11	12	13	14	15	16

BASE MODEL

Digit 1, 2: GENERATION
CB

Digit 3: REVISION
A = Design Sequence

Digit 4,5,6: UNIT SIZE
024 = 24 MBH (2 Ton)
036 = 36 MBH (3 Ton)
048 = 48 MBH (4 Ton)
060 = 60 MBH (5 Ton)

Digit 7: VOLTAGE
1 = 208-230V/1Φ/60Hz
2 = 208-230V/3Φ/60Hz
3 = 460V/3Φ/60Hz

Digit 8: COMPRESSOR TYPE
B = Two Step Scroll Compressor
F = Two Step Scroll with Sound Blanket

Digit 9: NUMBER OF CIRCUITS
1 = One Circuit

FEATURE 1: AMBIENT CONTROL

Digit 10:
0 = Standard (55°F Ambient)
A = Fan Cycling (35°F Ambient)
B = Adjustable Fan Cycling (35°F Ambient)

FEATURE 2: REFRIGERATION OPTIONS

Digit 11:
0 = Standard, Split System Air Conditioner
A = External Hot Gas Bypass
B = Split System Heat Pump
D = Modulating Hot Gas Reheat
F = Option A + D
G = Option B + D

FEATURE 3: CONTROLS

Digit 12:
0 = Standard, Terminal Block
H = Control Circuit Transformer

FEATURE 4: COIL PROTECTION

Digit 13:
0 = Standard, Copper Tube with Aluminum Fins
A = Polymer E-Coated Coil
B = Copper Finned Coil with Stainless Steel Casing

FEATURE 5: CABINET OPTIONS

Digit 14:
0 = Standard - Louvers
A = Wire Grille
C = Anti-Corrosion Paint
J = Option A + C

FEATURE 6: Warranty

Digit 15:
0 = Standard
A = Second to Fifth Year Extended Compressor Warranty

FEATURE 7: TYPE

Digit 16:
0 = Standard
X = Special Pricing Authorization

CC Base Model and Features Description

Model/Feature Number

C	C	-	A	-	0	1	0	-	3	-	B	-	2	:	A	D	0	0	0	A	0
1	2		3		4	5	6		7		8		9		10	11	12	13	14	15	16

BASE MODEL

Digit 1, 2: GENERATION
CC

Digit 3: REVISION
A = Design Sequence

Digit 4,5,6: UNIT SIZE
006 = 6 Tons
007 = 7 Tons
008 = 8 Tons
010 = 10 Tons
013 = 13 Tons
016 = 16 Tons
020 = 20 Tons
025 = 25 Tons
030 = 30 Tons
040 = 40 Tons
050 = 50 Tons
060 = 60 Tons

Digit 7: VOLTAGE
1 = 208-230V/1Φ/60Hz
2 = 208-230V/3Φ/60Hz
3 = 460V/3Φ/60Hz

Digit 8: COMPRESSOR TYPE
A = Single Step Scroll Compressor
B = Two Step Scroll Compressor
C = Tandem Scroll Compressors

Digit 9: NUMBER OF CIRCUITS
2 = Two Circuits

FEATURE 1: AMBIENT CONTROL

Digit 10:
0 = Standard (55°F Ambient)
A = Fan Cycling (35°F Ambient)
B = Adjustable Fan Cycling (35°F Ambient)

FEATURE 2: REFRIGERATION OPTIONS

Digit 11:
0 = Standard, Split System Air Conditioner
A = External Hot Gas Bypass
B = Split System Heat Pump
D = Modulating Hot Gas Reheat
F = Option A + D
G = Option B + D

FEATURE 3: CONTROLS

Digit 12:
0 = Standard, Terminal Block with Control Transformer
A = Suction Pressure Transducer
B = Phase and Brown Out Protection
C = 115V Convenience Outlet (Field Wired)
D = Options A + B
E = Options A + C
F = Options B + C
G = Options A + B + C

FEATURE 4: COIL TYPE

Digit 13:
0 = Standard, Copper Tube with Aluminum Fins
A = Polymer Coated Condenser Coil
B = Copper Finned Coil with Stainless Steel Casing

FEATURE 5: CABINET OPTIONS

Digit 14:
0 = Standard, Louvers
C = Anti-Corrosion Paint Exterior

FEATURE 6: WARRANTY

Digit 15:
0 = Standard
A = Second to Fifth Year Extended Compressor Warranty

FEATURE 7: TYPE

Digit 16:
0 = Standard
X = Special Price Authorization

Model Number
Revision

Example: CC-**A**-010-3-B-2:AD000A0

A = *Design Sequence* - This digit is used for future product updates, improvements, and revisions.

Model Number
Unit Size

Example: CC-A-**010**-3-B-2:AD000A0

Unit size designates nominal MBH cooling/nominal gross tons cooling for CB/CC condensing units. Actual capacities will vary with conditions. Refer to the Performance Data section of this catalog and the AAONEcat32™ software for performance and cooling capacities at design conditions.

Table M1 - Unit Sizes

Model	Compressors/ Circuits	Nominal Values					
		MBH	Tons	Width	Height	Length	Weight
CB-**024**	1/1	24	2	31”	39”	36”	257
CB-**036**		36	3				
CB-**048**		48	4	37”	43”	36”	306
CB-**060**		60	5				
CC-**006**	2/2	72	6	42”	40”	55”	534
CC-**007**		84	7				
CC-**008**		96	8	44”	50”	86”	844
CC-**010**		120	10				854
CC-**013**		156	13			99”	980
CC-**016**		192	16				1,054
CC-**020**		240	20				1,074
CC-**025**	4/2	300	25	78”	54”	105”	2,065
CC-**030**		360	30				2,095
CC-**040**		480	40		67”		2,283
CC-**050**		600	50	78”	68”	150”	2,853
CC-**060**		720	60				2,903

Model Number
Voltage

Example: CC-A-010-**3**-B-2:AD000A0

All units except 25 Ton and larger units have single point power blocks with grounding lugs, 24 VAC control circuits, and branch circuit fusing. 25 Ton and larger units have dual power blocks.

1 = 208-230V/1Φ/60Hz
2 = 208-230V/3Φ/60Hz
3 = 460V/3Φ/60Hz

Model Number
Compressor Type

Example: CC-A-010-3-**B-**2:AD000A0

A = *Single Step Scroll Compressor* - Conventional single stage scroll compressors. Includes compressor crankcase heaters. Available on CC-013, CC-016, and CC-020 units, which include two single step scroll compressors and are factory wired for two stage of cooling.
B = *Two Step Scroll Compressor* - Two step scroll compressor(s) that provides two stages of capacity, 67% and 100%, for energy efficient part load operation. Includes compressor crankcase heater(s). Available on CB Series condensing units, which include a single two step compressor, and CC-008 and CC-010, which include a pair of two step compressors. CB Series units are factory wired for two stage cooling. CC-008 and CC-010 are factory wired for two stage cooling, with an adjustable time delay relay for the second step of each compressor, and unit may be field rewired if 4 stage cooling is required.
C = *Tandem Scroll Compressors* - Two single stage scroll compressors connected in tandem to provide two stages of capacity, for energy efficient part load operation. Includes compressor crankcase heaters. Available on CC-025 to CC-60 units, which include a pair of tandem single stage scroll compressors. CC-025 to CC-060 are factory wired for two stage cooling, with an adjustable time delay relay for the second compressor in each tandem circuit, and unit may be field rewired if 4 stage cooling is required.
F = *Two Step Scroll Compressor with Sound Blanket* - Same as B except includes high density foam sound suppression blanket on unit compressor to dampen radiated sound. Available on CB Series units only.

Model Number
Number of Circuits

Example: CC-A-010-3-B-**2**:AD000A0

1 = *One Circuit* - Single refrigeration circuit. Available on CB Series units only.
2 = *Two Circuits* - Two refrigeration circuits. Available on CC Series units only.

Feature 1
Ambient Control

Example: CC-A-010-3-B-2:**A**D000A0

0 = *Standard* (55°F Ambient) - 55°F fixed compressor lockout for cooling mode.
A = *Fan Cycling* (35°F Ambient) - Low ambient head pressure control option that cycles the condenser fans to maintain refrigerant circuit head pressures at acceptable levels during compressor operation. Fans cycle on at 416 psi and off at 340 psi. Minimum allowable ambient temperature for cooling mode is 35°F.
B = *Adjustable Fan Cycling* (35°F Ambient) - Same as option A except allows field adjustment of the head pressure control setpoint (100-470 psi) and the pressure differential (35-200 psi). Minimum allowable ambient temperature for cooling mode is 35°F.

Feature 2
Refrigeration Options

Example: CC-A-010-3-B-2:A**D**000A0

0 = *Standard - Split System Air Conditioner* - Manual reset high pressure cutouts, automatic reset low pressure cutouts, and 5 minute off compressor time delay relays. Liquid line filter dryer is factory provided and field installed with CB Series condensing units and factory installed in CC Series condensing units.
A = *External Hot Gas Bypass* - Field adjustable pressure activated bypass valve on the cooling circuit(s) factory setup to divert hot compressor discharge gas to the evaporator coil if pressure on the evaporator side of the valve drops below 105 psi (34°F at sea level). The bypass valve is at full capacity after six degrees of differential (28°F at sea level). This option prevents coil freeze-up during periods of low airflow or cold entering coil conditions. This option is used for refrigerant system protection only and cannot be used for cooling capacity modulation. Requires additional field piped hot gas bypass line from condensing unit to air handler.

Feature 2 - Refrigeration Options Continued

B = *Split System Heat Pump* - Energy efficient heating option available only with selection of matching heat pump air handler. Includes factory installed reversing valve, suction line accumulator, heat pump TXV valve, and field installed and factory provided heat pump filter dryer and liquid line receiver tank.
D = *Modulating Hot Gas Reheat* - Dehumidification option available only with selection of matching air handler with the modulating hot gas reheat option. Digital controller and modulating valves control the flow of refrigerant to the reheat coil, mounted downstream of the evaporator coil in the air handler, to maintain precise supply air temperature during dehumidification. A humidistat is required and available as an accessory. Liquid line filter dryer is factory provided and field installed with CB Series condensing units and factory installed in CC Series condensing units. Liquid line receiver, reheat coil check valve, and liquid line check valve are factory provided and field installed. Requires additional field piped hot gas line from condensing unit to air handler. Field installed suction line accumulator is recommended.
F = *External Hot Gas Bypass + Modulating Hot Gas Reheat* - Options A + D. A humidistat is required, and available as an accessory. Liquid line filter dryer is factory provided and field installed with CB Series condensing units and factory installed in CC Series condensing units. Liquid line receiver, reheat coil check valve, and liquid line check valve are factory provided and field installed. Requires additional field piped hot gas line from condensing unit to air handler. Field installed suction line accumulator is recommended. Option available only with selection of matching air handler with the external hot gas bypass and modulating hot gas reheat option.
G = *Split System Heat Pump + Modulating Hot Gas Reheat* - Options B + D. A humidistat is required, and available as an accessory. Includes factory installed reversing valve, suction line accumulator, heat pump TXV valve, and field installed and factory provided liquid line receiver, reheat coil check valve, and heat pump filter dryer. Requires additional field piped hot gas line from condensing unit to air handler. Option available only with selection of matching heat pump air handler with the modulating hot gas reheat option.

Feature 3
Controls

Example: CC-A-010-3-B-2:AD**0**00A0

0 = *Standard - Terminal Block* - Power and starting components include fan motor contactors, 5 minute off compressor time delay relays, internal fan motor overload protection and unit power terminal block for connection to remote disconnect switch. Safety and operating controls include manual reset high pressure switches, and automatic reset low pressure switches. CB Series option does not include control circuit (24V) transformer. CC Series option includes control circuit (24V) transformer.
A = *Suction Pressure Transducer* - Available on CC Series units only.

Feature 3 - Controls Continued

B = *Phase & Brown Out Protection* - This selects a three phase power monitor that shuts down the unit if the supplied power phases are out of balance, or over/under voltage, or in case of a phase loss. Option is used to protect motors and compressors from electrical phase loss or low voltage brownout. Reset is automatic. Available on CC Series units only.
C = *115V Convenience Outlet, Field Wired* - Field wired 2x4 electrical box with ground fault interrupter receptacle, located inside the unit controls cabinet. Receptacle is rated for 13 amps. The outlet must be field wired to an 115VAC power supply. Available on CC Series units only.
D = *Suction Pressure Transducer + Phase & Brown Out Protection* - Options A + B. Available on CC Series units only.
E = *Suction Pressure Transducer + 115V Convenience Outlet and Transformer, Factory Wired* - Options A + C. Available on CC Series units only.
F = *Phase & Brown Out Protection + 115V Convenience Outlet and Transformer, Factory Wired* - Options B + C. Available on CC Series units only.
G = *Suction Pressure Transducer + Phase & Brown Out Protection + 115V Convenience Outlet and Transformer, Factory Wired* - Options A + B + C. Available on CC Series units only.
H = *Control Circuit Transformer* - Available on CB Series units only. CC Series units come standard with a control circuit (24V) transformer.

Feature 4
Coil Protection

Example: CC-A-010-3-B-2:AD0**0**0A0

0 = *Standard, Copper Tube with Aluminum Fin* - Condenser coil(s) are constructed of copper tubing mechanically bonded to enhanced aluminum fins with galvanized steel casing. CB Series units utilize single row, bent coil construction for easy cleaning. CC Series units utilize multiple row, unbent slab coil construction for easy cleaning.
A = *Polymer E-Coated Coil* - Polymer e-coating applied to the condenser coil(s) and casing(s). Coating surpasses a 6000 hour salt spray test per ASTM B117-90, yet is only 0.8-1.2 mils thick and has excellent flexibility. Option may be used in coastal saltwater conditions under the stress of heat, salt, sand, and wind and is applicable to all corrosive environments where a polymer coating is acceptable.
B = *Copper Finned Coil with Stainless Steel Coil Casing* - Condenser coil(s) are constructed of copper tubing mechanically bonded to enhanced copper fins with 18GA 304 stainless steel casing. Select this option for applications requiring maximum corrosion resistance.

Feature 5
Cabinet Options

Example: CC-A-010-3-B-2:AD00**0**A0

0 = *Standard, Louvered Coil Protection* - Louvered panels fabricated from galvanized G90 steel are painted and factory mounted to protect the condenser coil face. Paint finish exceeds 1000 hour salt spray test when tested under ASTM B 117-95 requirements.
A = *Wire Grille* - Wire grille exterior condenser coil protection. With less restriction this option can provide better efficiencies. Available on CB Series units only.
D = *Anti-Corrosion Protection* - Cabinet is primer washed and then spray coated with a two part polyurethane, heat-baked coating. Polyurethane coating exceeds 2500 hours when tested under ASTM B 117-95 requirements. Option is intended for use in coastal saltwater conditions under the stress of heat, salt, sand, and wind and is applicable to all corrosive environments where a polyurethane coating is acceptable. See Feature 4 for coil and coil casing corrosion protection options.
K = *Wire Grille + Anti-corrosion Protection* - Options A + C. Available on CB Series units only.

Feature 6
Warranty Options

Example: CC-A-010-3-B-2:ADA000**A**0

0 = *Standard* - For commercial applications, each CB/CC series condensing unit purchased comes with a one year manufacturer's warranty effective from the start up date, not to exceed 18 months from date of shipment. The warranty covers material and workmanship defects.
A = *Second to Fifth Year Extended Compressor Warranty* - Extends warranty coverage of compressor(s) for the second to fifth years of unit operation.

Feature 7
Type

Example: CC-A-010-3-B-2:ADA000A**0**

0 = *Standard* - Painted cabinet exterior which exceeds 1000 hour salt spray test when tested under ASTM B 117-95 requirements.
X = *Special Price Authorization* - The Applications Department must issue a Special Pricing Authorization (SPA) to include a non-standard option.

General Data

Unit Information

Table G1 - CB Unit Data

	CB-024	CB-036	CB-048	CB-060
Compressor				
Type	R-410A Two Step Scroll			
Number/Nominal Tons	1/2	1/3	1/4	1/5
Crankcase Heater	Yes			
Condenser Fan				
Number/Diameter	1/22”		1/26”	
hp	1/3			
Condenser Coil				
Rows	1			
Liquid Line Connection	3/8”			
Suction Line Connection	3/4”		7/8”	
Nominal Unit Weight (lbs.)	257		306	

Table G2 - Matching F1 Unit Data

	F1-024	F1-036	F1-048	F1-060
Supply Blower				
Type/Diameter	FC (Forward Curved)/9”		FC/10”	
Standard Motor	1/2 hp		3/4 hp	
High Static Application Motor	3/4 hp		1 hp	
Nominal CFM	800	1200	1600	2000
Evaporator A-Coil				
Refrigerant	R-410A			
Coil Face Area	4 ft^2		5.4 ft^2	
Rows/FPI	3/14		3/12	
Electric Heat				
kW Capacity - 230 V	5, 10	5, 10, 15	5, 10, 15, 20	5, 10, 15, 20, 25
kW Capacity - 208V	3.75, 7.5	3.75, 7.5, 11.25	3.75, 7.5, 11.25, 15	3.75, 7.5, 11.25, 15, 18.75
Stages	5, 10 kW - 1 stage / 15, 20 - 2 stage / 25 kW - 3 stage			
Hot Water Coil				
Coil Face Area	1.56 ft^2		1.88 ft^2	
Rows/FPI	4/10			
Condensate Drain	3/4” Connection			
Air Filter	20” x 20” x 1”			

Table G3 - CC Unit Data

	CC-006	CC-007	CC-008	CC-010
Compressors				
Type	R-410A Two Step Scroll			
Number/Nominal Tons	2/3	2/4	2/4	2/5
Number of Circuits	2			
Crankcase Heater	Yes			
Condenser Fans				
Number/Diameter	1/30”			
hp	0.75			
Liquid Line Connections	1/2”		1/2”	5/8”
Suction Line Connections	1/2”		7/8”	
Included Charge (lbs.) per Circuit	5			
Nominal Unit Weight (lbs.)	534		844	854

Table G4 - CC Unit Data

	CC-013	CC-016	CC-020
Compressors			
Type	R-410A Single Step Scroll		
Number/Nominal Tons	2/6	2/8	2/10
Number of Circuits	2		
Crankcase Heater	Yes		
Condenser Fans			
Number/Diameter	2/30”		
hp	0.75		
Liquid Line Connections	5/8”		
Suction Line Connections	1 1/8”		1 3/8”
Included Charge (lbs.) per Circuit	5		6
Nominal Unit Weight (lbs.)	980	1,054	1,074

Table G5 - CC Unit Data

	CC-025	CC-030	CC-040	CC-050	CC-060
Compressors					
Type	R-410 Single Step Scroll - Tandem				
Number/Nominal Tons	4/7	4/8	4/10	4/13	4/15
Number of Circuits	2				
Crankcase Heater	Yes				
Condenser Fans					
Number/Diameter	4/30”			6/30”	
hp	0.75				
Liquid Line Connections	5/8”	7/8”			
Suction Line Connections	1 1/8”	1 5/8”			
Included Charge (lbs.) per Circuit	8			13	
Nominal Unit Weight (lbs.)	2,065	2,095	2,283	2,853	2,903

Electrical Information

Table E1 - CB and CC Electrical Data

Model	Voltage	Unit			Compressor	Condenser Fan
		FLA	MCA	MOP	Quantity / RLA	Quantity / hp / FLA
CB-024	208-230/1Φ	14.2	17.1	25.0	1 / 11.4	1 / 0.33 / 2.8
CB-036		21.4	26.0	40.0	1 / 18.6	
CB-048		26.4	32.3	50.0	1 / 23.6	
CB-060		31.4	38.5	60.0	1 / 28.6	
CC-006		42.5	47.2	60.0	2 / 18.6	1 / 0.75 / 5.4
CC-007		52.5	58.4	80.0	2 / 23.6	
CC-008		52.5	58.4	80.0	2 / 23.6	
CC-010		62.5	69.7	90.0	2 / 28.6	
CB-036	208-230/3Φ	15.2	18.3	25.0	1 / 12.4	1 / 0.33 / 2.8
CB-048		17.8	21.6	35.0	1 / 15.9	
CB-060		22.4	27.4	45.0	1 / 19.6	
CC-006		30.3	33.4	45.0	2 / 12.4	1 / 0.75 / 5.4
CC-007		35.4	39.2	50.0	2 / 15.0	
CC-008		35.4	39.2	50.0	2 / 15.0	
CC-010		44.7	49.6	60.0	2 / 19.6	
CC-013		62.5	69.0	90.0	2 / 25.9	2 / 0.75/ 5.4
CC-016		76.5	84.7	110.0	2 / 32.9	
CC-020		85.1	94.4	125.0	2 / 37.1	
CC-025		133.0	140.0	150.0	4 / 27.9	4 / 0.75 / 5.4
CC-030		153.0	161.2	175.0	4 / 32.9	
CC-040		170.2	179.5	200.0	4 / 37.1	
CC-050		261.0	275.3	300.0	4 / 57.1	6 / 0.75 / 5.4
CC-060		281.0	296.5	350.0	4 / 62.1	
CB-036	460/3Φ	7.8	9.1	15.0	1 / 5.0	1 / 0.33 / 2.8
CB-048		9.9	11.7	15.0	1 / 7.1	
CB-060		12.8	15.3	25.0	1 / 10.0	
CC-006		12.8	14.1	15.0	2 / 5.0	1 / 0.75 / 2.8
CC-007		17.1	18.9	25.0	2 / 7.1	
CC-008		17.1	18.9	25.0	2 / 7.1	
CC-010		22.8	25.3	35.0	2 /10.0	
CC-013		30.6	33.7	45.0	2 / 12.5	2 / 0.75 / 2.8
CC-016		38.5	42.6	50.0	2 / 16.4	
CC-020		45.6	50.6	70.0	2 / 20.0	
CC-025		65.5	68.9	80.0	4 / 13.6	4 / 0.75 / 2.8
CC-030		76.9	81.0	90.0	4 / 16.4	
CC-040		91.2	96.2	110.0	4 / 20.0	
CC-050		119.7	126.1	150.0	4 / 25.7	6 / 0.75 / 2.8
CC-060		136.8	144.3	150.0	4 / 30.0	

Table E2 - Matching F1 Supply Fan and Unit Electrical Data

Unit Voltage	Supply Fan		Unit		
	hp	FLA	FLA	MCA	MOP
208-230V/1Φ	0.5	4.2	4.2	5.0	15.0
	0.75	5.4	5.4	7.0	15.0
	1.0	8.0	8.0	10.0	15.0
115V/1Φ	0.5	7.7	7.7	9.6	15.0
	0.75	9.6	9.6	12.0	15.0
	1.0	12.8	12.8	16.0	20.0

Table E3 - Matching F1 Electric Heat Electrical Data

Unit Voltage	kW	Circuit #	Amps	MCA	MOP
208-230V/1Φ	5	1	21	26.0	30
	10	1	42	52.1	60
	15	1	42	52.1	60
		2	21	26.0	30
	20	1	42	52.1	60
		2	42	52.1	60
	25	1	42	52.1	60
		2	42	52.1	60
		3	21	26.0	30

Note: Electric heat is not available on 115V/1Φ F1 Series air handler

Performance Data

Table P1 - Matching CB and F1, Air Conditioner Performance Data

Condensing Unit	Air Handler	Nominal Capacity	SEER
CB-024	F1-024	24 MBH / 2 Tons	17.2
CB-036	F1-036	36 MBH / 3 Tons	15.5
CB-048	F1-048	48 MBH / 4 Tons	15.6
CB-060	F1-060	60 MBH / 5 Tons	14.6

Table P2 - Matching CB and F1, Heat Pump Performance Data

Condensing Unit	Air Handler	Nominal Capacity	SEER	HSPF
CB-024	F1-024	24 MBH / 2 Tons	16.30	8.45
CB-036	F1-036	36 MBH / 3 Tons	14.80	8.50
CB-048	F1-048	48 MBH / 4 Tons	14.65	8.65
CB-060	F1-060	60 MBH / 5 Tons	14.40	8.30

Table P3 - Matching CB and AU, Air Conditioner Performance Data

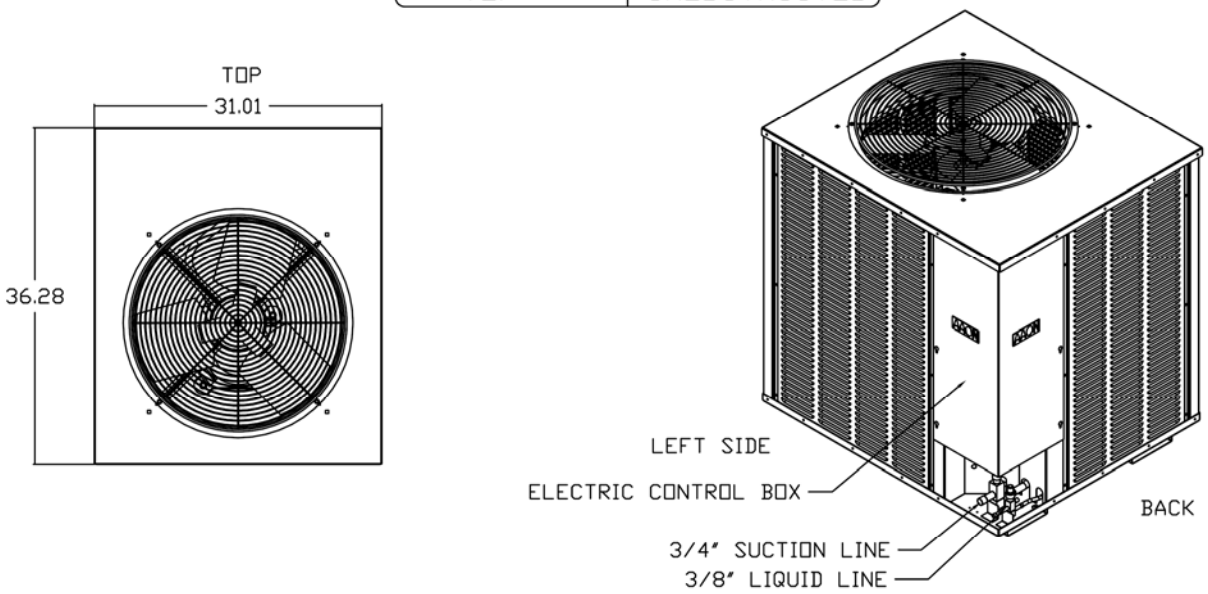
Condensing Unit	A-Coil	Nominal Capacity	SEER
CB-024	AU-024	24 MBH / 2 Tons	14.95
CB-036	AU-036	36 MBH / 3 Tons	14.78
CB-048	AU-048	48 MBH / 4 Tons	14.46
CB-060	AU-060	60 MBH / 5 Tons	13.53

Table P4 - Matching CB and AU, Heat Pump Performance Data

Condensing Unit	Air Handler	Nominal Capacity	SEER	HSPF
CB-024	F1-024	24 MBH / 2 Tons	14.17	8.91
CB-036	F1-036	36 MBH / 3 Tons	14.33	9.05
CB-048	F1-048	48 MBH / 4 Tons	14.12	9.38
CB-060	F1-060	60 MBH / 5 Tons	13.10	8.66

Unit Drawings

CLEARANCES	
LOCATION	CB 2-3 TON
BACK	10″
FRONT	36″
LEFT SIDE	36″
RIGHT SIDE	36″
TOP	UNOBSTRUCTED



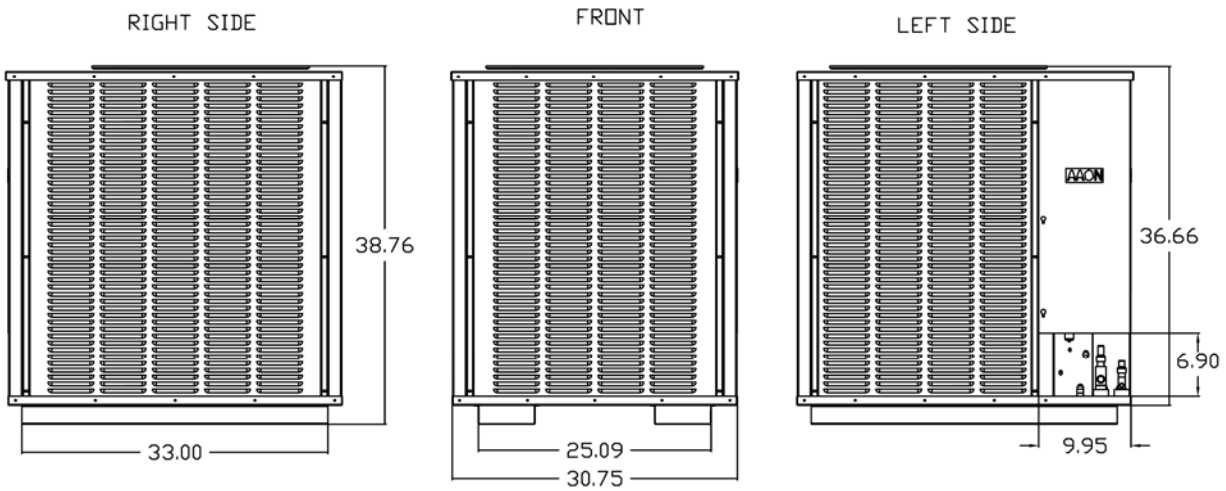


Figure U1 - CB-024 and CB-036 Condensing Units

CLEARANCES	
LOCATION	CB 4-5 TON
BACK	10″
FRONT	36″
LEFT SIDE	36″
RIGHT SIDE	36″
TOP	UNOBSTRUCTED

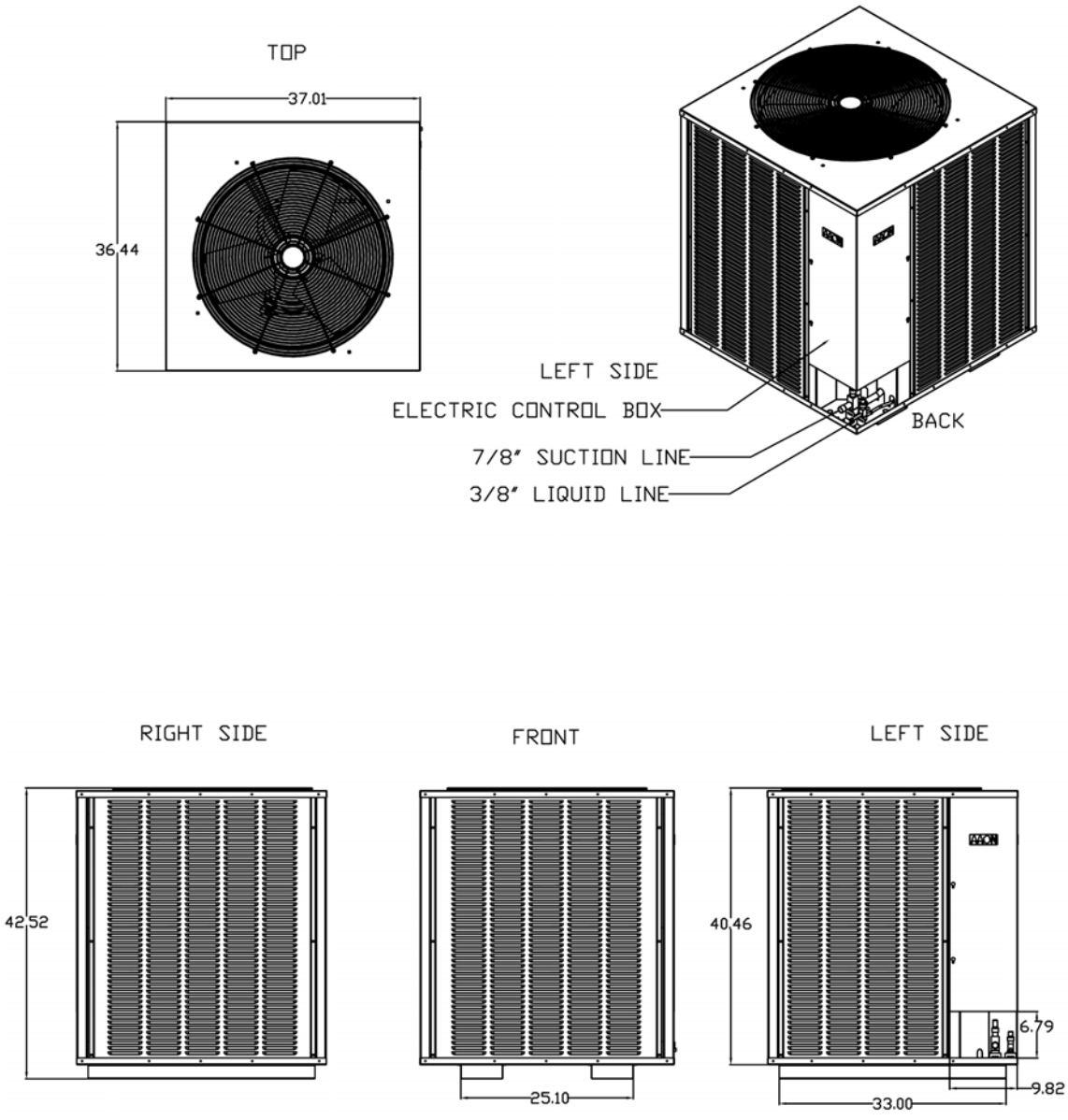


Figure U2 - CB-040 and CB-060 Condensing Units

CLEARANCES	
LOCATION	CC 6-7 TON
BACK	48″
FRONT	48″
LEFT SIDE	36″
RIGHT SIDE	36″
TOP	UNOBSTRUCTED

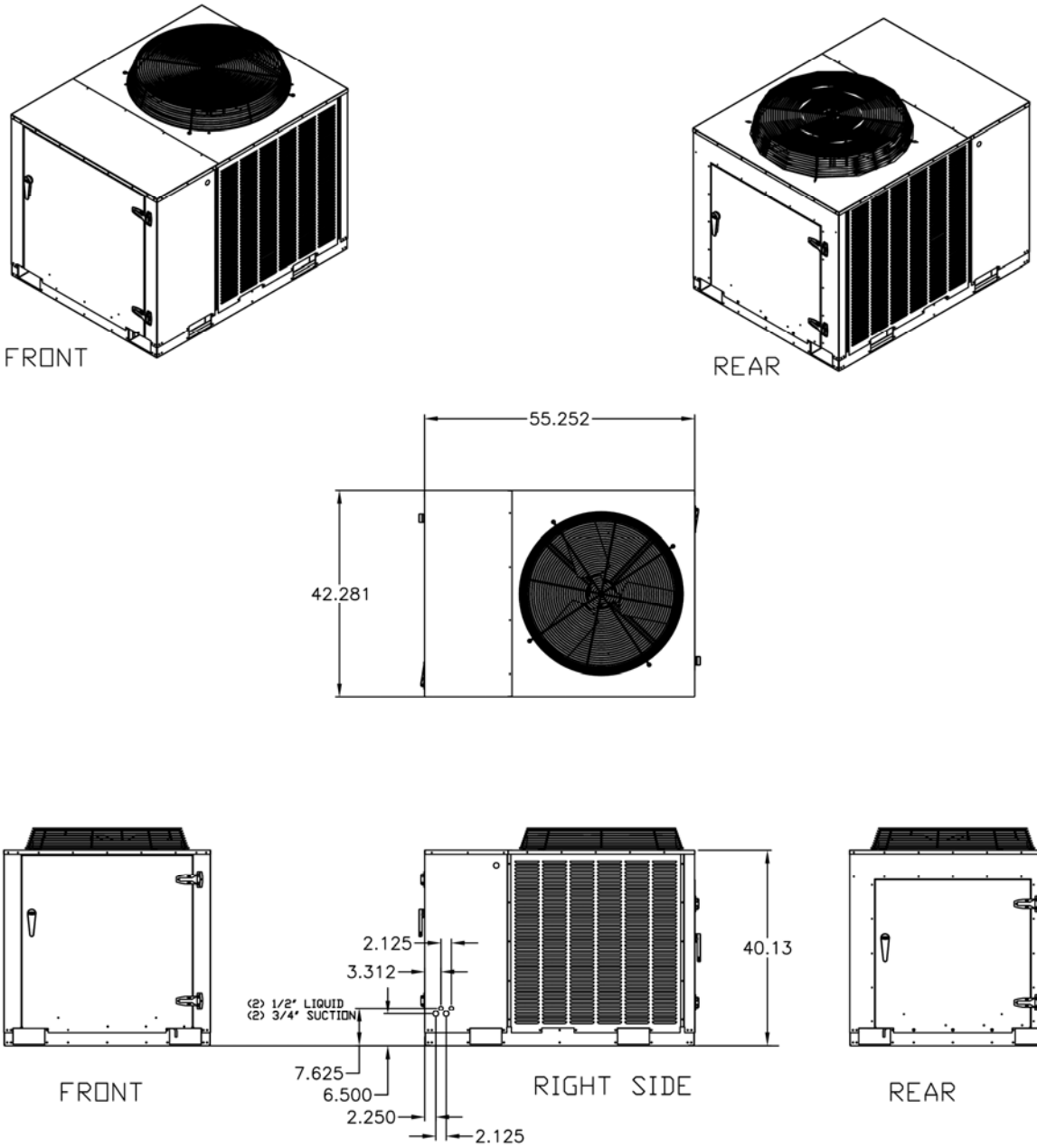


Figure U3 - CC-006 and CB-007 Condensing Units

CLEARANCES	
LOCATION	CC 08-10 TON
BACK	48″
FRONT	48″
LEFT SIDE	36″
RIGHT SIDE	36″
TOP	UNOBSTRUCTED

LINE SIZES		
UNIT SIZE	SUCTION	LIQUID
8 TONS	7/8″	1/2″
10 TONS	7/8″	5/8″

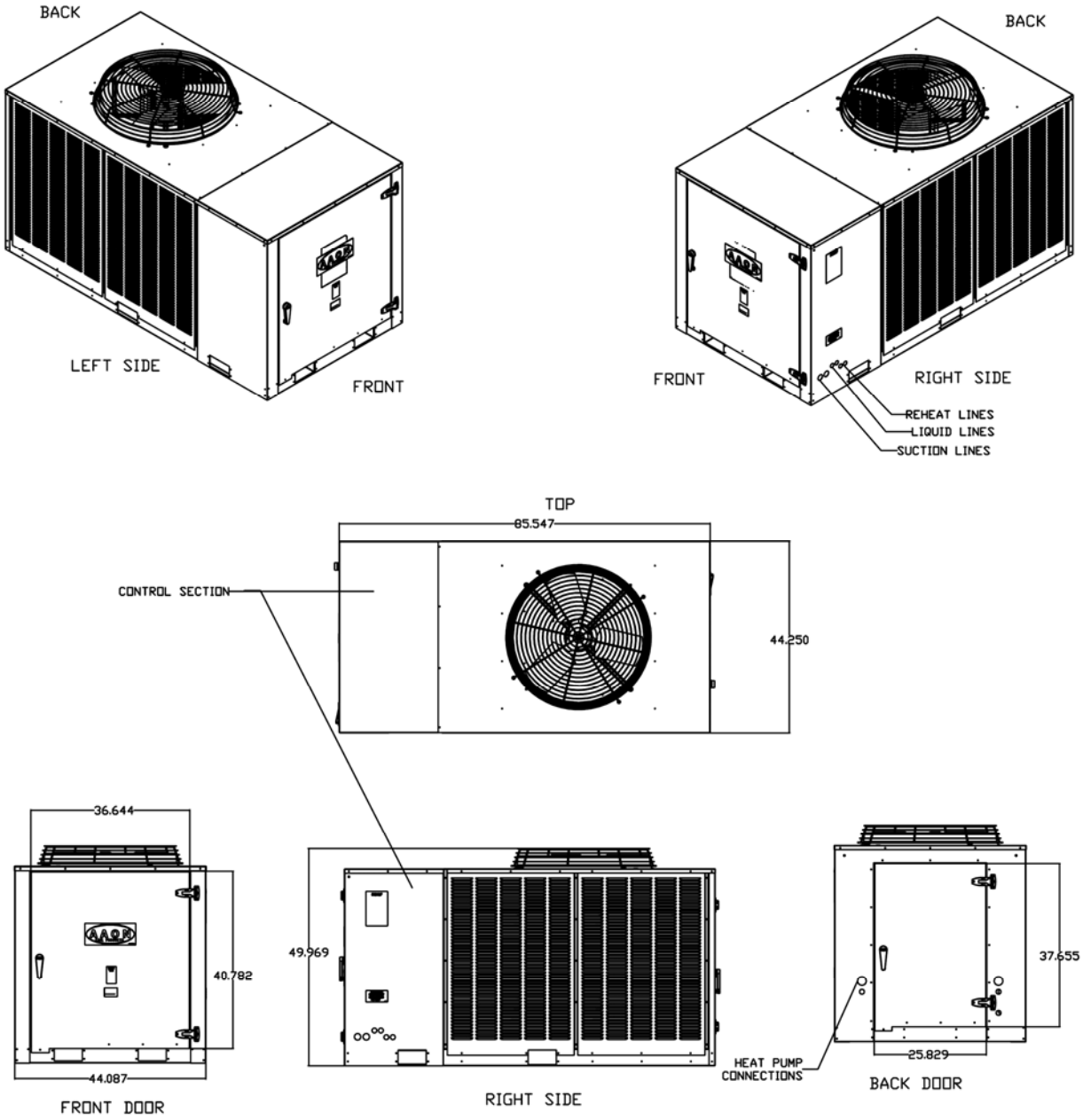


Figure U4 - CC-008 and CC-010 Condensing Units

CLEARANCES	
LOCATION	CC 13-20 TON
BACK	48″
FRONT	48″
LEFT SIDE	36″
RIGHT SIDE	36″
TOP	UNOBSTRUCTED

LINE SIZES		
UNIT SIZE	SUCTION	LIQUID
13 TONS	1 1/8″	5/8″
16 TONS	1 1/8″	5/8″
20 TONS	1 3/8″	5/8″

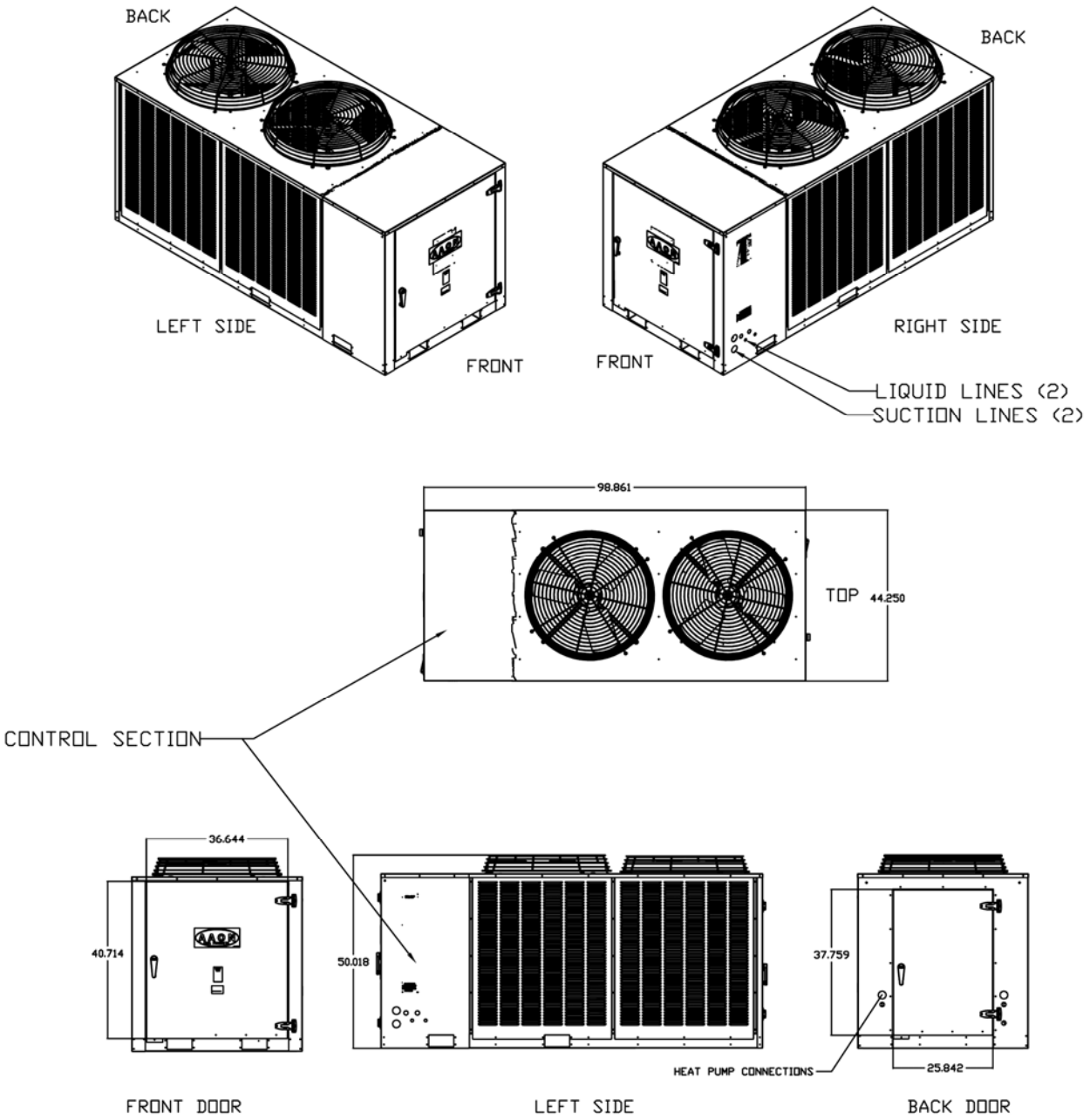


Figure U5 - CC-013, CC-016, and CB-020 Condensing Units

CLEARANCES	
LOCATION	CC 25 TON
BACK	39"
FRONT	39"
LEFT SIDE	36"
RIGHT SIDE	36"
TOP	UNOBSTRUCTED

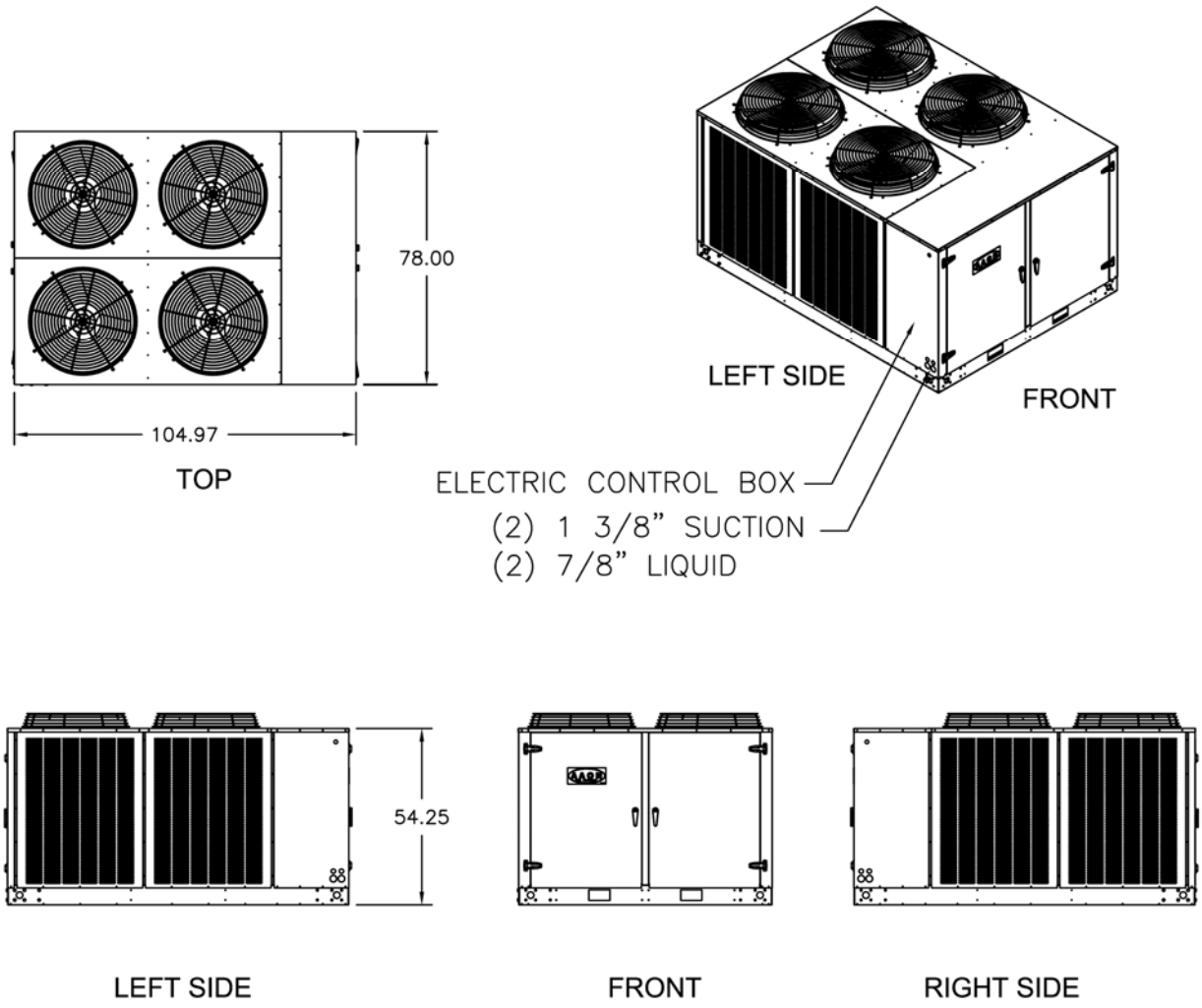


Figure U6 - CC-025 Condensing Unit

CLEARANCES	
LOCATION	CC 30 TON
BACK	39"
FRONT	39"
LEFT SIDE	36"
RIGHT SIDE	36"
TOP	UNOBSTRUCTED

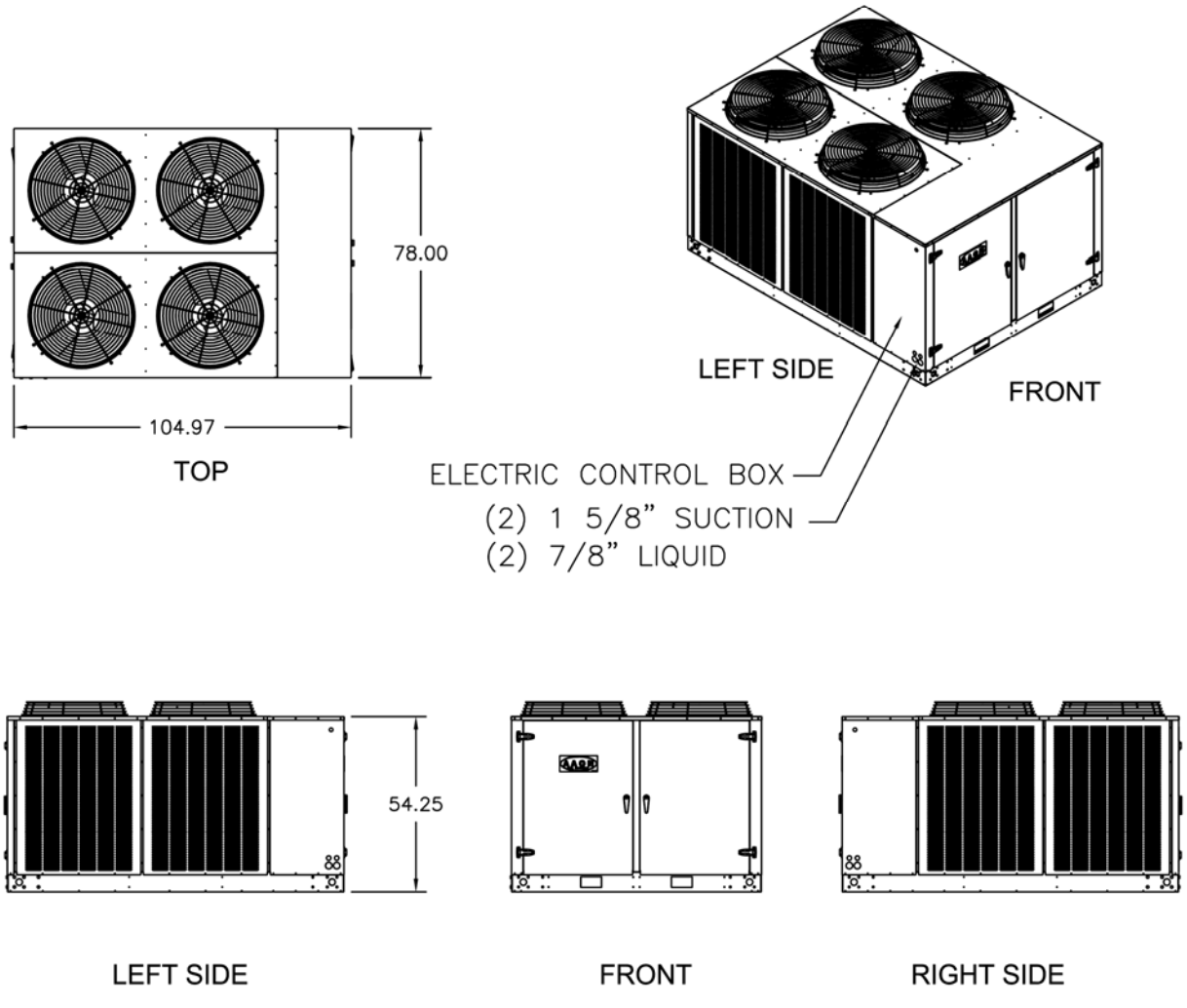


Figure U7 - CC-030 Condensing Unit

CLEARANCES	
LOCATION	CC 40 TON
BACK	39"
FRONT	39"
LEFT SIDE	36"
RIGHT SIDE	36"
TOP	UNOBSTRUCTED

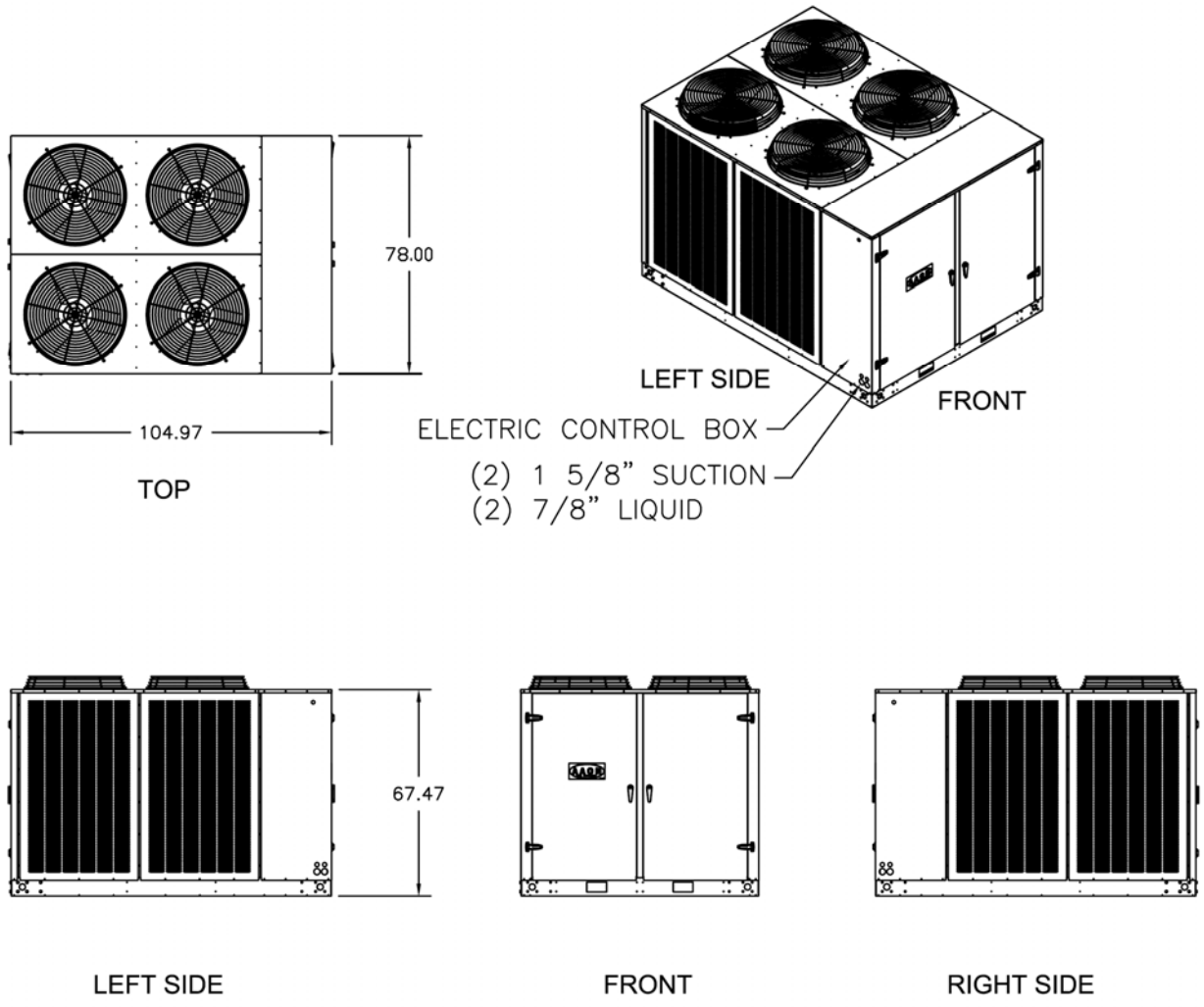


Figure U8 - CC-040 Condensing Unit

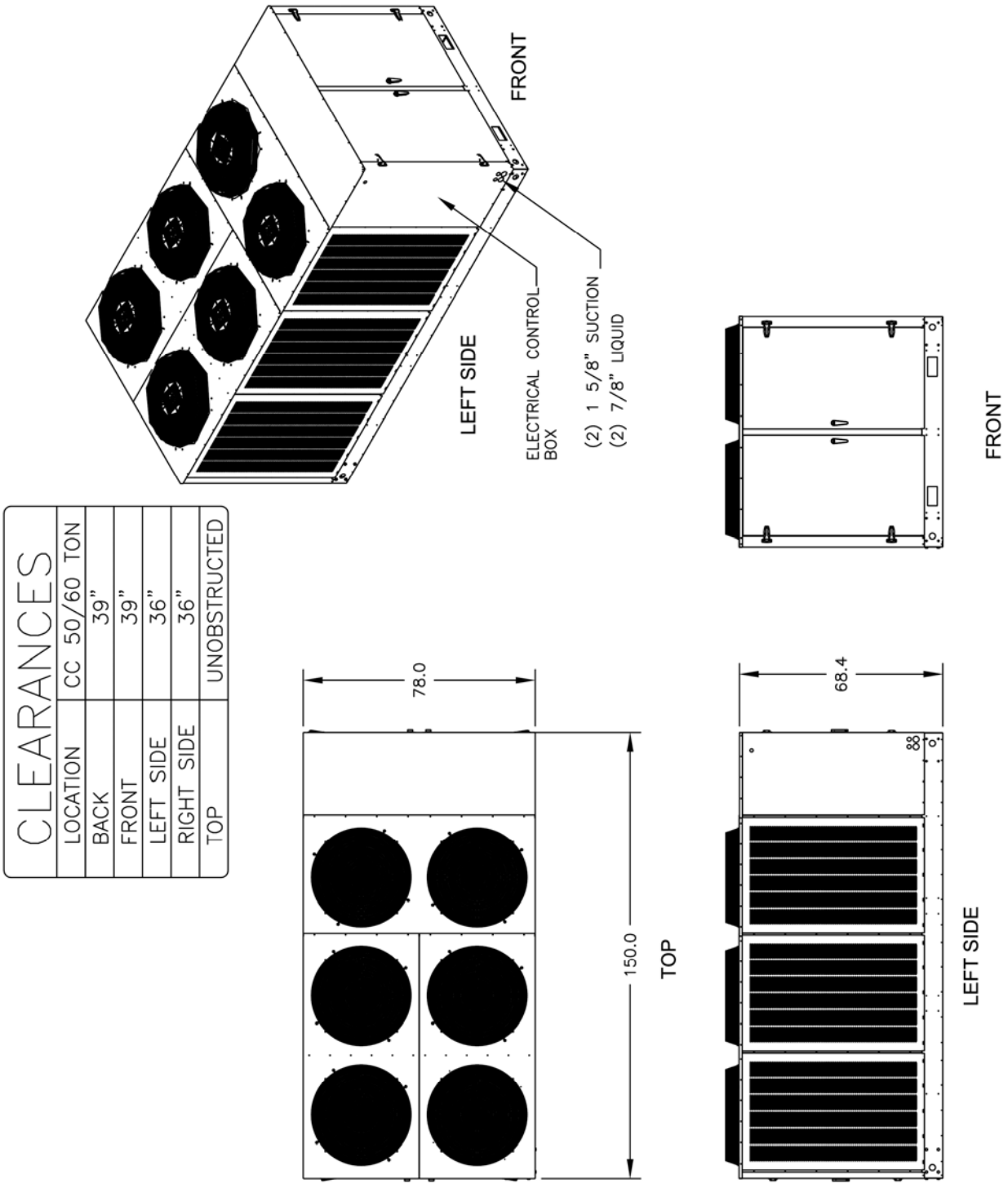


Figure U9 - CC-050 and CC-060 Condensing Units

Guide Specifications - AAON CB Series Condensing Units

SECTION 15XXX – CONDENSING UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this section.

1.02 SUMMARY

A. This Section includes design, refrigerants, controls, and installation requirements for air-cooled scroll compressor condensing units.

1.03 REFERENCES

A. Comply with the applicable Standards and/or Codes of ETL, cETL, NEC, ASHRAE Standard 90.1, and OSHA as adopted by the state.

1.04 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities of selected model clearly indicated, dimensions, required clearances, shipping, installed, and operating weights, furnished specialties, accessories, and installation and startup instructions.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location of each field connection. Detail equipment mounting to supporting structure.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

C. Commissioning Reports: Indicate results of startup and testing commissioning requirements. Submit copies of checklists.

D. Maintenance Data: Maintenance manuals specified in Division 1.

E. Warranties: Special warranties specified in this Section.

1.05 QUALITY ASSURANCE

A. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

B. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.

1. The condensing unit shall be safety certified by ETL and the nameplate shall carry the agency label.

1.06 DELIVERY AND HANDLING

A. Condensing unit shall be delivered to the jobsite with factory holding charge and be factory charged with oil by the manufacturer.

B. Comply with the manufacturer's instructions for rigging and handling equipment.

1.07 WARRANTY

A. The refrigeration equipment manufacturer's warranty shall be for a period of one year from date of equipment start up but not more than 18 months from date of shipment. The warranty shall cover material and workmanship that prove defective within the above period, excluding refrigerant.

Options:

1. Compressors shall carry a 5 warranty.

2. With a residential CB and F1 or CB and AU matched split system, manufacturer's warranty shall be for a period of 5 (10) years. Warranty shall begin on the date of the original installation, or three months after date of original shipment from the factory (as shown on the warranty certificate), whichever occurs first. The warranty shall cover material and workmanship that prove defective within the above period, under normal use and maintenance. Refer to the Limited Warranty Certificate.

1.08 MAINTENANCE

A. Maintenance of the unit shall be responsibility of the owner and performed in accordance with the manufacturer's instructions.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to strict compliance with the requirements of this specification, provide products by one of the following:

1. Condensing Units:

    a. AAON

2.02 CONDENSING UNITS

A. Unit Description: Provide and install as shown on the plans, factory assembled, air-cooled scroll compressor condensing units in the quantity specified. Each unit shall consist of an air-cooled condenser section with hermetic scroll compressor and isolated control compartment containing: control system, suction and liquid connection valves, and all components necessary for safe and controlled unit operation when connected to the specified low side equipment.

Option:

1. Condensing unit and matching indoor air handler shall be capable of operation as a split system heat pump.

B. Construction:

1. Unit shall be completely factory assembled, piped, and wired and shipped in one section.

2. Unit shall be specifically designed for outdoor application.

3. Paint finish shall be capable of withstanding at least 1000 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.

4. The condenser coil shall be mechanically protected from physical damage by painted galvanized steel louvers covering the full area of the coil.

Options (Multiple selections are permissible):

a. Paint finish shall be capable of withstanding at least 2500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.

b. The condenser coil shall be mechanically protected from physical damage by a wire guard covering the full area of the coil.

2.03 DESIGN REQUIREMENTS

A. General: Provide a complete scroll compressor condensing unit as specified herein and as shown on the drawings. The unit shall be in accordance with the standards referenced in section 1.03 and any local codes in effect.

B. Performance: Refer to the schedule of performance on the unit rating page. The unit shall be capable of stable cooling operation to a minimum of 55°F outdoor temperature.

2.04 CONDENSING UNIT FEATURES

A. Compressor:

1. The compressor shall be two step, single circuited, sealed hermetic scroll type, with inherent thermal overload protection and shall be mounted on rubber vibration isolators.

2. Each compressor shall be furnished with a crankcase heater.

Options:

1. The compressor shall be covered by a high-density foam sound attenuating blanket to reduce radiated noise.

B. Condenser:

1. The condenser coil shall consist of seamless copper tubes mechanically bonded into plate type aluminum fins. The fins shall have full drawn collars to completely cover the tubes. A subcooling section shall be an integral part of the main condenser coil.

2. The condenser fan shall be propeller type arranged for vertical air discharge, and driven by a direct drive fan motor. The fan discharge area shall be equipped with a heavy-gauge fan guard.

3. Fan motor shall be weather protected, single phase, direct drive, ECM 2.3 motor.

Options:

a. Coil shall have a flexible epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Coating process shall ensure complete coil encapsulation and a uniform dry film thickness from 0.8 to 1.2 mils on all surface areas including fin edges. Superior hardness characteristics of 2H per ASTM D3363-92A and a cross-hatch adhesion of 4B-5B per ASTM B3359-93. Impact resistance shall be up to 160 in/lb per ASTM D2794-93. Humidity and water immersion resistance shall be up to a minimum 1000 and 250 hours respectively (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing to no less than 6000 hours salt spray per ASTM

B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of e-coat.

b. Coil shall be copper tubes with copper fins mechanically bonded to the tubes, and 304 stainless steel end casings.

C. Refrigerant Circuit:

1. The condensing unit shall operate with R-410A refrigerant. The condensing unit shall be furnished with a liquid line filter drier and service valves for liquid and suction connections. The finished field installed refrigerant circuit furnished by the contractor shall include the low side cooling components, refrigerant, thermal expansion valve, liquid line, (insulated hot gas bypass line) (insulated hot gas line), and insulated suction line.

Options:

a. External hot gas bypass shall be provided on the refrigerant circuit.

b. Condensing unit shall be provided with condenser head pressure control to allow cooling operation down to 35°F.

c. Condensing unit shall be provided with adjustable condenser head pressure control to allow cooling operation down to 35°F.

d. Unit shall dehumidify using modulating hot gas reheat control valves, an electronic controller, and a matching air handler that includes a hot gas reheat coil. Field installed liquid line receiver tank shall be factory provided.

D. Control System:

1. A centrally located weatherproof control panel shall be isolated from condenser coil airflow, and shall contain the field power connection points, control terminal block and control system.

2. Power and starting components shall include fan motor contactors, 5 minute off time delay relays for the compressor, inherent fan motor overload protection and unit power terminal blocks for connection to remote disconnect switch. Safety and operating controls shall include a manually reset high pressure switch and an automatic reset low pressure switch. Barrier panels shall be furnished to protect against accidental contact with line voltage when accessing the control system.

Option:

a. Control circuit transformer and wiring shall provide 24V control voltage from the line voltage provided to the unit.

E. Wiring Diagrams:

1. Color-coded and marked wiring diagrams shall be provided to match the color and markings of the unit wiring.

2. Diagrams shall be laminated in plastic and permanently fixed to the control compartment door.

3. Installation, Operation, and Maintenance manual shall be supplied with unit within the control compartment.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install in strict accordance with manufacturer's requirements, shop drawings, and contract documents.

B. Adjust and level unit on supports.

C. Install refrigerant piping in accordance with drawings.

D. Evacuate the system and charge with refrigerant in accordance with standard practice.

E. Coordinate electrical installation with electrical contractor.

F. Coordinate controls with control contractor.

G. Provide all appurtenances required to insure a fully operation and functionally system.

3.02 STARTUP

A. Check and assure proper system charge of refrigerant and oil.

B. Provided testing, and starting of system, and instruct the Owner in its proper operation and maintenance.

Guide Specifications - AAON CC Series Condensing Units

SECTION 15XXX – CONDENSING UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this section.

1.02 SUMMARY

A. This Section includes design, refrigerants, controls, and installation requirements for air-cooled scroll compressor condensing units.

1.03 REFERENCES

A. Comply with the applicable Standards and/or Codes of ETL, cETL, NEC, ASHRAE Standard 90.1, and OSHA as adopted by the state.

1.04 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities of selected model clearly indicated, dimensions, required clearances, shipping, installed, and operating weights, furnished specialties, accessories, and installation and startup instructions.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location of each field connection. Detail equipment mounting to supporting structure.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

C. Commissioning Reports: Indicate results of startup and testing commissioning requirements. Submit copies of checklists.

D. Maintenance Data: Maintenance manuals specified in Division 1.

E. Warranties: Special warranties specified in this Section.

1.05 QUALITY ASSURANCE

A. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

B. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.

1. The condensing unit shall be safety certified by ETL and the nameplate shall carry the agency label.

1.06 DELIVERY AND HANDLING

A. Condensing unit shall be delivered to the jobsite with factory holding charge and be factory charged with oil by the manufacturer.

B. Comply with the manufacturer's instructions for rigging and handling equipment.

1.07 WARRANTY

A. The refrigeration equipment manufacturer's warranty shall be for a period of one year from date of equipment start up but not more than 18 months from date of shipment. The warranty shall cover material and workmanship that prove defective within the above period, excluding refrigerant.

Option:

1. Compressors shall carry a 5 warranty.

1.08 MAINTENANCE

A. Maintenance of the unit shall be responsibility of the owner and performed in accordance with the manufacturer's instructions.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to strict compliance with the requirements of this specification, provide products by one of the following:

1. Condensing Units:

a. AAON

2.02 CONDENSING UNITS

A. Unit Description: Provide and install as shown on the plans, factory assembled, air-cooled scroll compressor condensing units in the quantity specified. Each unit shall consist of an air-cooled condenser section and isolated control compartment containing:

hermetic scroll compressors, control system, suction and liquid connection valves, and all components necessary for safe and controlled unit operation when connected to the specified low side equipment.

B. Construction:

1. Unit shall be completely factory assembled, piped, and wired and shipped in one section.

2. Unit shall be specifically designed for outdoor application.

3. Paint finish shall be capable of withstanding at least 1000 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.

4. The condenser coil shall be mechanically protected from physical damage by painted galvanized steel louvers covering the full area of the coil.

Option:

a. Paint finish shall be capable of withstanding at least 2500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.

2.03 DESIGN REQUIREMENTS

A. General: provide a complete scroll compressor condensing unit as specified herein and as shown on the drawings. The unit shall be in accordance with the standards referenced in section 1.03 and any local codes in effect.

B. Performance: Refer to the schedule of performance on the unit rating page. The unit shall be capable of stable cooling operation to a minimum of 55°F outdoor temperature.

2.04 CONDENSING UNIT FEATURES

A. Compressor:

1. The compressors shall be (two step) (single circuited) (tandem) sealed hermetic scroll type, with inherent thermal overload protection and shall be mounted on rubber vibration isolators.

2. Each compressor shall be furnished with a crankcase heater.

B. Condenser:

1. The condenser coils shall consist of seamless copper tubes mechanically bonded into plate type aluminum fins. The fins shall have full drawn collars to completely cover the tubes. A subcooling section shall be an integral part of the main condenser coil.

2. The condenser fan(s) shall be propeller type arranged for vertical air discharge, and driven by a direct drive fan motor. The fan discharge area shall be equipped with a heavy-gauge fan guard.

3. Fan motor(s) shall be weather protected, single-phase, direct drive, 1100 rpm, open drip-proof type.

Options:

a. Coils shall have a flexible epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Coating process shall ensure complete coil encapsulation and a uniform dry film thickness from 0.8 to 1.2 mils on all surface areas including fin edges. Superior hardness characteristics of 2H per ASTM D3363-92A and a cross-hatch adhesion of 4B-5B per ASTM B3359-93. Impact resistance shall be up to 160 in/lb per ASTM D2794-93. Humidity and water immersion resistance shall be up to a minimum 1000 and 250 hours respectively (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing to no less than 6000 hours salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of e-coat.

b. Coils shall be copper tubes with copper fins mechanically bonded to the tubes, and 304 stainless steel end casings.

C. Refrigerant Circuit:

1. The condensing unit shall operate with R-410A refrigerant. The condensing unit shall be furnished with liquid line filter driers and service valves for liquid and suction connections. The finished field installed refrigerant circuit furnished by the contractor shall include the low side cooling components, refrigerant, thermal expansion valve, liquid line (insulated hot gas bypass line) (insulated hot gas line) and insulated suction line.

Options:

a. External hot gas bypass shall be provided on the refrigerant circuit.

b. Condensing unit shall be provided with condenser head pressure control to allow cooling operation down to 35°F.

c. Condensing unit shall be provided with adjustable condenser head pressure control to allow cooling operation down to 35°F.

d. Unit shall dehumidify using modulating hot gas reheat control valves, an electronic controller, and a matching air handler that include a hot gas reheat coil. Field installed liquid line receiver tank shall be factory provided.

D. Control System:

1. A centrally located weatherproof control panel shall be isolated from condenser coil airflow, and shall contain the field power connection points, control terminal block and control system.

2. Control circuit transformer and wiring shall provide 24V control voltage from the line voltage provided to the unit.

3. Power and starting components shall include fan motor contactors, 5 minute off time delay relay(s) for the compressor(s), inherent fan motor overload protection and unit power terminal blocks for connection to remote disconnect switch. Safety and operating controls shall include a manually reset high pressure switch and an automatic reset low pressure switch. Barrier panels shall be furnished to protect against accidental contact with line voltage when accessing the control system.

E. Wiring Diagrams:

1. Color-coded and marked wiring diagrams shall be provided in both "point-to-point" and "ladder" to match the color and markings of the unit wiring.

2. Diagrams shall be laminated in plastic and permanently fixed to the control compartment door.

3. Installation, Operation, and Maintenance manual shall be supplied with unit within the control compartment.

F. Power Options:

1. Unit shall be provided with phase and brown-out protection to shut down all motors in the unit if the phases are more than 10% out of balance on voltage, or the voltage is more than 10% under design voltage or on phase reversal.

2. Unit shall be provided with a factory installed and wired 115 volt, 12 amp ground fault service receptacle powered by a 1.5 kVA transformer.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install in strict accordance with manufacturer's requirements, shop drawings, and contract documents.

B. Adjust and level unit on supports.

C. Install refrigerant piping in accordance with drawings.

D. Evacuate the system and charge with refrigerant in accordance with standard practice.

E. Coordinate electrical installation with electrical contractor.

F. Coordinate controls with control contractor.

G. Provide all appurtenances required to insure a fully operation and functionally system.

3.02 STARTUP

A. Check and assure proper system charge of refrigerant and oil.

B. Provided testing, and starting of system, and instruct the Owner in its proper operation and maintenance.

AAON
2425 South Yukon Ave.
Tulsa, OK 74107-2728
Phone: 918-583-2266
Fax: 918-583-6094
www.aaon.com

CB/CC Series Engineering Catalog
R59070 · Rev. A · 080312
(ACP 29222)

F1 SERIES

AIR HANDLERS

INSTALLATION, OPERATION & MAINTENANCE

⚠ WARNING

If the information in this manual is not followed exactly, a fire or explosion may result causing pr operty damage, personal injury or loss of life.

⚠ WARNING

FOR YOUR SAFETY
Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

TABLE OF CONTENTS

Message to the Homeowner
These instructions are addressed primarily to the installer; however, useful maintenance information is included and this manual should be kept, after installation, for future reference.

Owner should pay particular attention to the words: NOTE, CAUTION AND WARNING. NOTES are intended to clarify or make the installation easier. CAUTIONS are given to prevent equipment damage. WARNINGS are given to alert owner that personal injury and/or equipment damage may result if installation procedure is not handled properly.

It is the intent of AAON to provide accurate and current specification information. However, in the interest of product improvement, AAON reserves the right to change pricing, specifications and/or design of its products without notice, obligation or liability.

R58420 · Rev. A · 080402
(ACP 29902)

GENERAL DESCRIPTION

Important Safety Information:

ONLY QUALIFIED PERSONNEL SHOULD PERFORM INSTALLATION, OPERATION, AND MAINTENANCE OF EQUIPMENT DESCRIBED IN THIS MANUAL.

F1 Series air handlers are designed for safe operation when installed, operated and maintained within design specifications and the instructions set forth in this manual. It is necessary to follow these instructions to avoid personal injury or damage to equipment or property during equipment installation, operation, start-up and maintenance.

⚠ WARNING

The information in this manual should be followed exactly to prevent property damage or personal injury.

⚠ IMPORTANT

This equipment is protected by a standard limited warranty under the condition that initial installation, service, start-up, and maintenance is performed according to the instructions set forth in this manual. This manual should be read in its entirety prior to installation and before performing any service or maintenance work.

⚠ WARNING

RISK OF DAMAGE, INJURY, AND LOSS OF LIFE – Improper installation, adjustment, alteration, service, or maintenance can cause property damage, personal injury, or loss of life. A qualified installer or service agency must perform installation and service.

⚠ WARNING

RISK OF ELECTRICAL SHOCK – Unit may have multiple power supplies. Turn the electrical power to the unit OFF at disconnect switch(es) before attempting to perform any service or maintenance.

⚠ WARNING

RISK OF INJURY FROM HOT PARTS – Disconnect all power before servicing electric resistance heating elements to prevent serious injury resulting from automatic starts. Unit may have multiple power supplies.

⚠ WARNING

RISK OF INJURY FROM MOVING PARTS – Disconnect all power before servicing motor or blower to prevent serious injury resulting from automatic starts. Motor and blower may have multiple power supplies.

⚠ IMPORTANT

These units must not be used as a "construction heater" at any time during any phase of construction. Very low return air temperatures, harmful vapors, and misplacement of the filters will damage the unit and its efficiency.

DELIVERY

ALL SHIPMENTS ARE FOB THE FACTORY. IT IS THE RESPONSIBILITY OF THE RECEIVING PARTY TO INSPECT THE EQUIPMENT UPON ARRIVAL.

Receipt and Inspection:
Check the unit model number, specifications, electrical characteristics and accessories to determine if they are correct. In the event an incorrect unit is shipped, it must be returned to the supplier and must NOT be installed. The manufacturer assumes no responsibility for installation of incorrectly shipped units.

Units should be inspected for damage that may have occurred in transit. **Please do not refuse shipments!** Do the following upon receipt:

1. Ensure that freight carrier is in compliance with Bill of Lading instructions.
2. Inspect delivery before signing Bill of Lading.

If damage is found or items are missing:

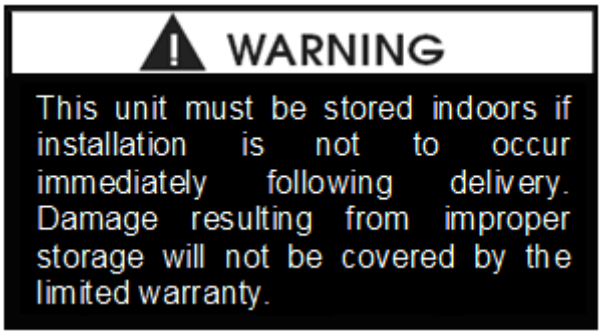
1. Note on Bill of Lading immediately.
2. Call carrier immediately to file a freight claim and to schedule an inspection.
• Photograph damage if possible.
• Do not move or discard damaged freight packaging materials.
3. After losses have been acknowledged by the freight carrier, contact factory for a repair or replacement part quote.
4. With permission of freight carrier, order parts and/or make repairs.
5. Stay in contact with freight carrier to ensure payment of your claim.

If repairs must be made to damaged goods, then the factory should be notified before any repair action is taken in order to protect the warranty. Certain equipment alteration, repair and manipulation of equipment without the manufacturer's consent may void the product warranty. Contact the Warranty Department for assistance with handling damaged goods, repairs and freight claims through www.aaon.com.

Note: Upon receipt, check shipment for items that ship loose such as thermostats, remote sensors, check valves, receiver tanks, etc. Consult order and shipment documentation to identify potential loose-shipped items. Loose-shipped items may have been placed inside unit cabinet for security.

Before Beginning Installation
Carefully read all instructions for the installation prior to installing unit. Make sure each step or procedure is understood and any special considerations are taken into account before starting installation. Assemble all tools, hardware and supplies needed to complete the installation. Some items may need to be purchased locally. After deciding where to install unit, closely look the location over - both the inside and outside of home. Note any potential obstacles or problems that might be encountered as noted in this manual. Choose a more suitable location if necessary.

Storage:
• This equipment is not suitable for outdoor use or storage. Never place this equipment where it may be subjected to outdoor conditions such as rain, snow, humidity, extreme temperatures or corrosive chemicals.
• If installation will not occur immediately following delivery, store equipment in a dry protected area away from construction traffic, and in the proper orientation as marked on the packaging with all internal packaging in place. Secure all loose-shipped items.



INSTALLATION

General:
F1 series air handling units are designed as a self-contained heating, cooling or combination units for indoor installation only. The refrigerant coils are designed for R-410A refrigerant only. Flexible connectors are required on all duct connections to minimize air leaks.

Certification:
1. Cooling Models
- Certified for use with a residential remote R-410A condensing unit with a two-step compressor.
- Certified for indoor installation only

2. Reheat Models
- Certified for use with a residential remote R-410A condensing unit with a two-step compressor and hot gas dehumidification capabilities.
- Certified for indoor installation only

3. Electric Heat Models
- Certified as an electric heating air handler with cooling coil.
- Certified for indoor installation only.

Codes and Regulations:
System should be sized in accordance with the American Society of Heating, Refrigeration and Air Conditioning Engineers Handbook.

The installation must conform with local building codes, or in the absence of local codes, with (United States) "ANSI / UL 1995", (Canada) current, C.S.A. Standard C22.2, No. 236, Canadian Electrical Code Part 1, and C.S.A. Standard B52 Mechanical Refrigeration Code, and Local Plumbing or Waste Water Codes.

IMPORTANT: THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (EPA) HAS ISSUED VARIOUS REGULATIONS REGARDING THE INTRODUCTION AND DISPOSAL OF REFRIGERANTS IN THIS UNIT. FAILURE TO FOLLOW THESE REGULATIONS MAY HARM THE ENVIRONMENT AND CAN LEAD TO THE IMPOSITION OF SUBSTANTIAL FINES. BECAUSE REGULATIONS MAY VARY DUE TO PASSAGE OF NEW LAWS, AAON SUGGESTS A CERTIFIED TECHNICIAN PERFORM ANY WORK DONE ON THIS UNIT. SHOULD YOU HAVE ANY QUESTIONS PLEASE CONTACT THE LOCAL OFFICE OF THE EPA.

⚠ WARNING

Do not, under any circumstances, connect duct work to any other heat producing device s uch as fireplace insert, stove, etc. Unauthorized u se of such dev ices may result in pro perty damage, fire, carbon monoxide poisoning, explosion, personal injury or death.

⚠ WARNING

It is the responsibility of the installing contractor to comply with codes, ordinances, local and municipal building laws, and manufacturer's instructions. Personal injury and/or equipment damage may result if proper proc edures are not followed.

Handling:
- Dependent upon the optional accessories that were ordered, this equipment may contain fragile components and delicate electronics. Although the unit is constructed of sturdy materials, avoid impacts and handling methods that may damage internal apparatus and structure of the unit. Take care not to apply destructive force to coils, coil and drain stub-outs, or other parts protruding beyond the extents of the unit casing. Always handle the unit by its exterior casing and never by any of the protruding parts.
- Keep equipment free from debris, and construction waste during installation. Foreign materials may adversely affect unit operation resulting in premature failures that will not be covered by the manufacturer's warranty. Attach all service panels, and cover all exposed

equipment when work is not being performed. Leave unit protected from other construction until start-up is to occur.

⚠ WARNING

Always wear hand and eye protection when handling, installing, servicing, or maintaining equipment. Sharp or pointed edges, moving parts, and flying debris may cause personal injury.

Service and Installation Clearance:

• Before setting the air handler into place, caution must be taken to provide clearance for unit panels that must be accessible for periodic service. These areas contain the controls, safety devices, refrigerant piping, shut-off valves and filter access.

• F1 series air handlers require a minimum of 36 inches of service clearance on the access panel side of the unit in order to ensure room for removal, replacement, or service of coils and other components if necessary.

Note: An auxiliary (emergency) drain pan is recommended for all applications where there is a risk of water damage to surrounding structure or furnishings. Refer to local codes.

Floor Mounted Units:

• Make sure that the unit is level, and mounted on a field-supplied platform with a minimum height of 12” to allow for proper fall on the condensate line. Other installation provisions may be necessary according to job specifications. F1 series air handlers are designed for up flow and horizontal applications only.

Suspended:

• The F1 series multiposition air handler can be easily suspended for suspended horizontal installations. The air handler should be lifted into position, supporting the entire unit from the bottom throughout the lift. Suspend the air handler as shown in the following Figure 1. An auxiliary drain pan that covers the entire unit would be required for above ceiling installations.

• The air handler must be installed level and care should be taken to prevent damage to the cabinet. Other installation provisions may be necessary according to job specifications and local code.

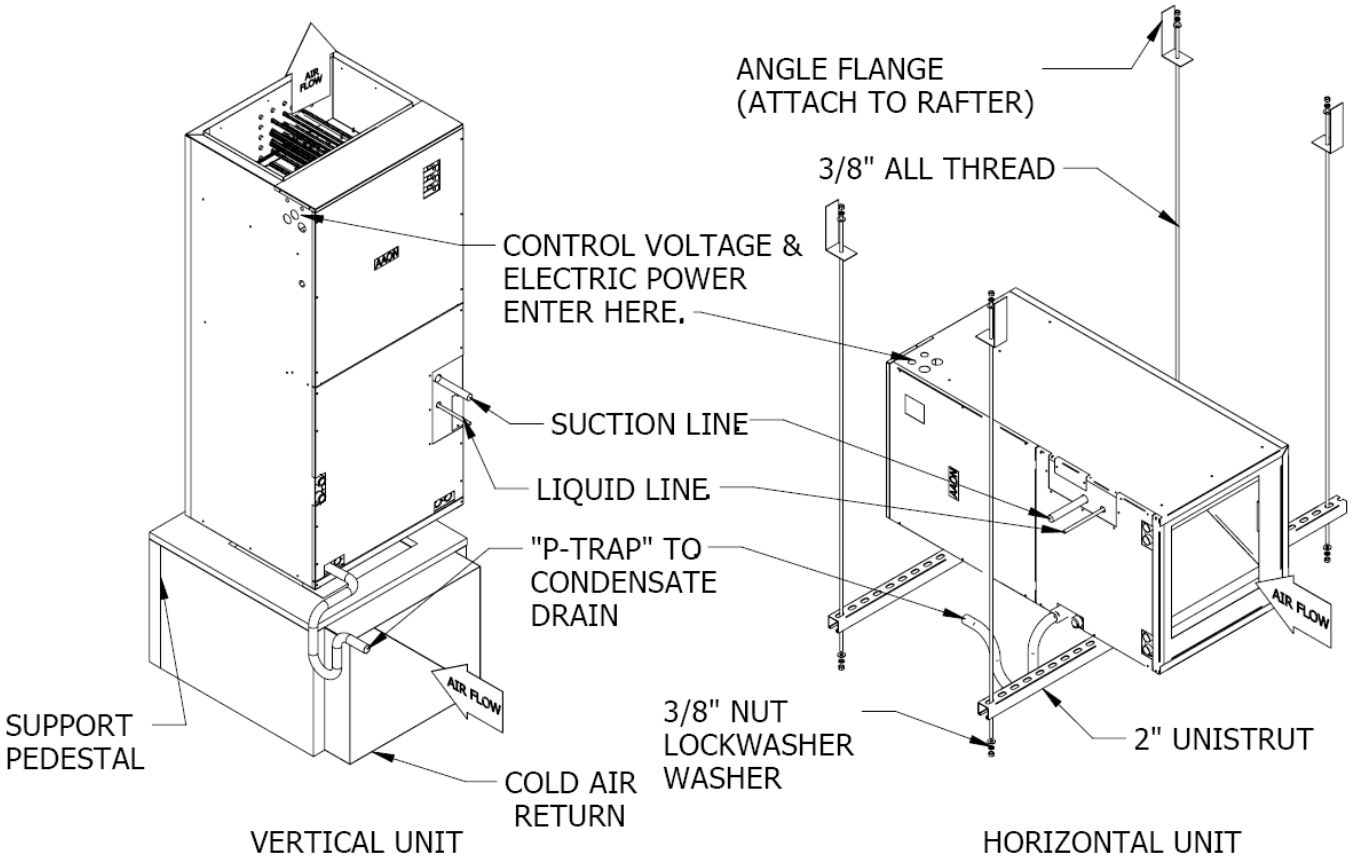


FIGURE 1. *Typical Vertical and Horizontal Unit Installation Methods.*

Sealing:

• It is very important to keep outside air from infiltrating the unit cabinet. Seal all piping penetrations with Armaflex, Permagum, or other suitable sealant. Also seal around drain connections, electrical connections, and other inlets where air may enter the cabinet. This is especially important when the unit is installed in an unconditioned area.

Cooling Equipment:

• Acceptable system design and installation will include consideration as follows:

• Piping from the condensing unit to the indoor air handler is the responsibility of the installing contractor.

• Only clean "ACR" tubing should be used.

• Piping should conform to generally accepted practices and codes.

• Care must be taken not to cross the circuits on reheat systems.

• Once piped, the interconnecting piping and air handler **MUST BE** evacuated to 500 microns or less; leak checked and condenser shutoff valves opened to allow refrigerant flow to air handler. Charge unit with R-410A refrigerant to recommended superheat/sub-cooling in the Charging Refrigerant section of this manual.

• **Make sure air handler thermal expansion valve bulb is mounted with good thermal contact on the suction line on a horizontal section, close to the evaporator but outside the cabinet in the 4 or 8 o'clock position and well insulated.**

• Lines should be fastened and supported according to local codes.

Heating Equipment:

Hot Water Heating:

• Water supply lines must be insulated, properly fastened, drained and supported according to local code requirements.

Electric Heating:

Installing Electric Heat Strip into the Unit:

1. Remove front control panel(s) of the unit
2. Remove screws and panel covering heat strip compartment
3. Open the heat strip kit and remove assembly from package
4. Install strip heat into opening and secure with 4 (four) screws
5. Install breaker assembly on bracket and secure with breaker with 4 (four) screws
6. Make sure that breaker is in the **OFF** position
7. Connect all control wires per wiring diagram included in the unit
8. Pull and install power wires per wiring diagram and MCA, MOP information herein and secure all wires firmly
9. Replace the front control panel(s) of the unit

FIELD INSTALLED WIRES SHOULD BE SINGLE STRAND WIRES. USE OF ROMEX WIRES IS NOT ACCEPTABLE.

• Heating is accomplished by passing electrical current through a specified amount of resistance heaters, which will produce the required heat. The indoor blower motor will energize at the same time as the heaters. Wiring to the air handler must be done in accordance with local electrical codes and/or standards. Check specified electrical rating and install with proper wire sizes. Also refer to wiring diagrams included with the unit for wire sizes and circuit breaker recommendations.

Field Wiring - MCA and MOP

Minimum Circuit Ampacity (MCA) and Maximum Overcurrent Protection (MOP) are necessary to correctly connect field wired equipment.

The calculations for the MCA and MOP are based on requirements of NFPA 70, the National Electrical Code (NEC) and CSA C22.1, the Canadian Electrical Code (CEC). The MCA is the minimum wire size needed to prevent the wiring from overheating during operating conditions for the life of the product. The MOP is the maximum allowable circuit breaker size that will properly disconnect power to the equipment under anticipated fault conditions.

In the following tables, locate the kW of the heater to be field installed, and then choose the corresponding MCA and MOP values to correctly size the wire gauge(s) and circuit breaker(s), respectively.

TABLE 1. Electric Heat Minimum Circuit Ampacity

230V	208V	Line 1	Line 2	Line 3
kW	***kW***	***MCA***	***MCA***	***MCA***
5	**3.75**	**26.0**		
10	**7.50**	**52.1**		
15	**11.25**	**52.1**	**26.0**	
20	**15.00**	**52.1**	**52.1**	
25	**18.75**	**52.1**	**52.1**	**26.0**

Overcurrent protection less than that recommended on the unit's "Specification Sheet" could result in unnecessary fuse failure and service call. The manufacturer bears no responsibility for damage caused to the equipment as a result of not using the recommended size for the protective devices as listed on the unit's rating plate.

TABLE 2. Electric Heat Maximum Overcurrent Protection

230V	208V	Line 1	Line 2	Line 3
kW	***kW***	***MOP***	***MOP***	***MOP***
5	**3.75**	**30**		
10	**7.50**	**60**		
15	**11.25**	**60**	**30**	
20	**15.00**	**60**	**60**	
25	**18.75**	**60**	**60**	**30**

Heat pump:

• For heat pump equipped split system configurations, the heat pump is the primary heat source during a call for heat. During operation at low ambient temperatures where the heat pump alone cannot satisfy the space temperature set point, electric resistance heat elements are activated. Below about 17°F, only the electric heat is operable; the heat pump is not active.

ECM Fan Motor:
The ECM has selectable fan speeds as determined by the configuration of four pins as shown in FIGURE 2.

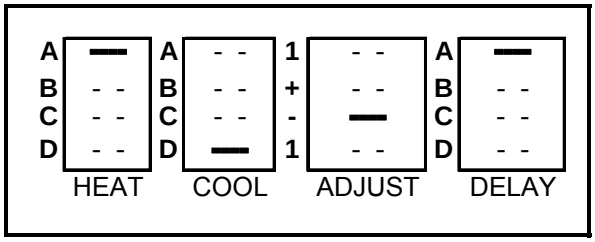


FIGURE 2. *Example configuration of ECM fan taps*

Adjust the taps as desired for cooling, dehumidification, and heating according to the following instructions.

Cooling:
Units are preprogrammed from the factory for a rated airflow rate of 400 CFM per ton as shown in TABLE 3.

TABLE 3. Factory Preset CFM

Model	Preset CFM
F1-060	2000
F1-048	1600
F1-036	1200
F1-024	800

* Maximum total static is 2.25" w.g.

The **high** speed for cooling may be selected by setting the COOL and ADJUST fan speed taps (shown in FIGURE 2). The setting combinations are shown in Table 4.

TABLE 4. Cooling Fan Speed Tap Settings

F1-060/ F1-048 (CFM)	F1-036/ F1-024 (CFM)	**COOL** Tap	**ADJUST** Tap
2000	1200	A	1
2000	1200	D	1
1840	1150	B	+
1700	1020	A	-
1700	1020	D	-
1600	1000	B	1
1380	920	C	+
1360	850	B	-
1200	800	C	1
1020	680	C	-

A signal from the thermostat, showing a need for dehumidification, will cause the unit to slow the fan speed in order to allow the air moving across the coil to get colder thereby better dehumidifying the air. Fist stage dehumidification has a low fan speed of 67% of the selected max speed. Second stage dehumidification has a fan speed of 45% of the selected max speed. NOTE: The Modulating Hot Gas Reheat option must be selected to have a second stage of dehumidification.

In this comfort cooling application of the ECM fan motor, heat and cool taps, A & D have the same effect on motor speed.

Humidity Control:
Adjust the DELAY tap for humidity control that is suitable for the climate according to TABLE 5.

TABLE 5. Climate Settings

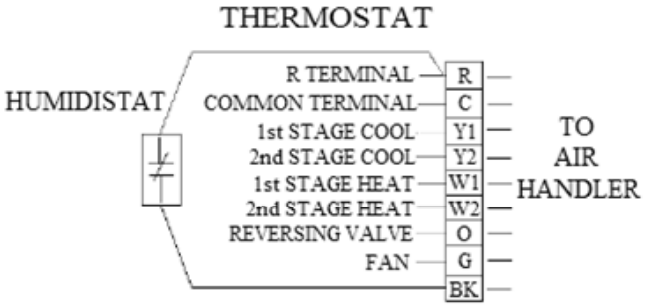
CLIMATE	**DELAY** Tap
Humid	A
Sub-humid/Dry	B
Semi-Arid	C
Arid/Hyper-Arid	D

Heating:
The fan speed for the heating cycle is selected by adjusting the HEAT tap (see FIGURE 2) according to TABLE 6.

TABLE 6. Heating Fan Speed Tap Settings		
F1-060/ F1-048 (CFM)	F1-036/ F1-024 (CFM)	**HEAT** Tap
1800	1000	A
1400	800	B
1200	600	C
1800	1000	D

ECM Fan notes:

1. Fan only = 50% of max speed
2. Dehumidifying speeds
   i) First stage dehumidification = 67% of max speed
   ii) Second stage dehumidification = 45% of max speed
3. Green Light will blink once per every 100 CFM
4. Dehumidification terminal is BK. There must be a constant voltage to this terminal, and when the voltage is dropped then dehumidification mode will begin.



Fan wiring notes:

1. If only one stage of cooling is used then jumper Y1 and Y2.
2. If unit is not heat pump capable then jumper O and Y1.
3. If no humidistat is used then jumper BK and R.
4. When only one stage of heat is used jumper W1 and W2.

Reheat Coil Refrigerant Piping:

The reheat coil is shipped already installed on the leaving air section of the air handler. A liquid receiver is shipped loose with the unit for field installation. (See Refrigerant Piping Section to determine acceptable refrigerant line size.)

1. Run a hot gas line from the outdoor unit and connect it to the inlet of the stub-out on the reheat coil.
   a. **For vertical (up-flow) units.** The inlet connection is the left stub-out when facing the front of the unit. Connect the hot gas line from the outdoor unit to the left stub-out. Connect the check valve (shipped loose) to the right stub-out in a direction so that the refrigerant flow is leaving the right side of the coil. Be sure to not block access for service of the air handler with the placement of the check valve.
   b. **For horizontal discharge units.** Connect the hot gas line from the outdoor unit to the upper stub-out connection of the reheat coil. Connect the check valve (shipped loose) to the lower stub-out in a direction so that the refrigerant is leaving the bottom side of the reheat coil. Be sure to not block access for service of the air handler with the placement of the check valve.
2. After installing the check valve, mount the receiver (shipped loose). The receiver tank must be mounted **horizontally** for proper operation. The receiver may be mounted on the air handler or at a convenient location near the air handler. Be sure to not block access for service of the air handler with the placement of the receiver.
3. After mounting the receiver, run a liquid line from the discharge of the check valve to the receiver tank through a tee connection. Run a liquid line from the condenser, through a check valve to the other side of the tee. *Note check valve in condenser liquid line is not used on heat pump models.* (See Refrigerant Piping Section to determine acceptable line size, location of components and to see a diagram depicting the finished line piping.)
4. After installing the receiver tank, run a liquid line from the receiver outlet to the TXV. (See Refrigerant Piping Section to determine acceptable line size and to see a diagram depicting the finished line piping.)

5. After completing the reheat and liquid lines, run a Suction line from the evaporator outlet to the outdoor unit shutoff valve (See Refrigerant Piping Section to determine acceptable line size.)
6. After completing the refrigerant piping installation, install the supply air temperature sensor (shipped loose) 18" from the leaving air outlet from the air handler.
7. After installing the supply air temperature sensor, check that the reheat supply air temperature setpoint is correctly set on the control board. This temperature should be set to the desired space temperature when the unit is in cooling mode. If that temperature is unknown at the time of installation, set the setpoint to 72°F.

The reheat system provides for "neutral" (neither hot nor cold) air to the space so that the unit can dehumidify the air without over cooling or over heating the space. The desired leaving air temperature is set on the control board in the unit. The factory suggests a setpoint of 72°F for most applications; however, the setpoint is adjustable for more specific applications or differing comfort levels. The setpoint should be set for the desired temperature in the space during cooling mode. During dehumidification mode the cooling coil operates and the modulating valve in the reheat system meters the amount of hot refrigerant being directed to the reheat coil so that the cooled and dehumidified air is reheated, to the setpoint provided on the control board, to a room neutral temperature. This temperature setpoint and method of dehumidification allows for the home to be dehumidified even when there is not a need for cooling in the space.

NOTE: SYSTEMS WITH THE MODULATING HOT GAS REHEAT (MHGR) OPTION WILL REQUIRE REFRIGERANT TO BE FIELD ADDED BECAUSE OF THE ADDITIONAL REFRIGERANT COMPONENTS AND PIPING ASSOCIATED WITH THE MHGR SYSTEM.

Condensate Piping:

• A drain trap must be connected to the drain pan at the unit. Condensate connections are provided on each side of the unit. Condensate piping should be installed according to local codes. The line should be the same pipe size as the drain nipple and should pitch downward toward the building drain.

• All cooling coils must have drain pans equipped with "P" traps to avoid pulling air from outside the unit back through the drain line. All drain connection ports are sealed. Knock out only the connection port to be used. The trap should be located in warm ambient spaces. An additional drain pan may be installed under the air handler, and should include a separate drain line for overflow from the primary drain. An air break should be used with long runs of condensate lines.

• Drain pans in any air conditioning equipment, even when they have a built-in slope to the drain, will have moisture present and will require periodic cleaning to prevent any build-up of algae or bacteria. Cleaning of the drain pans will also prevent any possible plugging of the drain lines, and overflow of the pan itself. Some means to clean out the "P" trap should be provided. Only qualified personnel should clean drain pans, drain lines, or the insides of equipment.

Electrical:

• Check the unit data plate to make sure it agrees with the power supply. Connect power to the unit according to the wiring diagram provided with the unit.

• The power and control wiring may be brought in through the holes provided on the unit. Protect the branch circuit in accordance with code requirements. If the control wires, are to run inside the same conduit, use 600-volt wire or as required by applicable codes.

• The units must be electrically grounded in accordance with the National Electric Code, ANSI / UL 1995 when installed if an external source is utilized; in Canada use current C.S.A. Standard C22.2, No. 236, Canadian Electric Code Part 1.

• Power wiring is to the unit terminal control board. The manufacturer has done all wiring beyond this point. Power can be applied to the unit after the control wiring is connected, and startup checks are complete.

Thermostat:
Units without the neutral air dehumidification feature will operate with most common thermostats. Units with the neutral air dehumidification feature must use thermostats with a normally closed (NC) dehumidification option. The following stats have been approved for usage with the dehumidification feature.

Robertshaw	**Honeywell**
9825i2	VisionPRO®IAQ

Filters:
Open filter access bracket and slide correct filter in with arrow pointing towards the blower in the direction of airflow. Replacement filters are 20" X 20" X 1".

Charging Refrigerant:
• The unit comes with full charge based on a 25-foot line set. Charging a system in the field must be based on determination of liquid sub-cooling and evaporator superheat. On a system with a thermostatic expansion valve, liquid sub-cooling is more representative of the charge than evaporator superheat but both measurements must be taken.

! IMPORTANT
The Clean Air Act of 1990 bans the intentional venting of refrigerant (CFC's and HCFC's) as of July 1, 1992. Approved methods of recovery, recycling or reclaiming must be followed. Fines and/or incarceration may be levied for non-compliance.

Before Charging:
• The unit being charged must be at or near full load conditions before adjusting the charge.
• Units equipped with hot gas reheat must have the hot gas reheat valves closed to get the proper charge.
• Units equipped with hot gas reheat must be charged with the hot gas valve closed while the unit is in cooling mode.
• After adding or removing charge the system must be allowed to stabilize, typically 10-15 minutes, before making any other adjustments.
• The type of unit and options determine the ranges for liquid sub-cooling and evaporator superheat. Refer to **TABLE 7** when determining the proper sub-cooling.
• The vertical rise of the liquid line must be known in order to adjust the sub-cooling range for proper charge.

Checking Liquid Sub-cooling:
1. Measure the temperature of the **liquid line** as it leaves the condenser coil.
2. Read the gauge pressure reading of the **liquid line** close to the point where the temperature was taken. You must use liquid line pressure, as it will vary from discharge pressure due to condenser coil pressure drop.
3. Convert the pressure obtained in Step 2 to a saturated temperature using the appropriate refrigerant temperature-pressure chart.
4. Subtract the measured liquid line temperature in Step 1 from the saturated temperature in Step 3 to determine the liquid sub-cooling.
5. Compare calculated sub-cooling to TABLE 7 for the appropriate unit type and options.

Checking Evaporator Superheat:
1. Measure the temperature of the **suction line** close to the compressor.
2. Read gauge pressure at the **suction line** close to the compressor.
3. Convert the pressure obtained in Step 2 to a saturated temperature using the appropriate refrigerant temperature-pressure chart.
4. Subtract the saturated temperature in Step 3 from the measured suction line temperature in Step 1 to determine the evaporator superheat.
5. Compare calculated superheat to TABLE 7 for the appropriate unit type and options.

Adjusting Sub-cooling and Superheat Temperatures:
The system is **overcharged** if:
1. the sub-cooling temperature is too high **and**
2. the evaporator is fully loaded (low loads on the evaporator result in increased sub-cooling) **and**
3. the evaporator superheat is within the temperature range as shown in TABLE 7 (high superheat results in increased sub-cooling)

TABLE 7			
	Sub-cooling (°F)	**Superheat (°F)**	**Sub-cooling W/Hot Gas Reheat (°F)**
Air Cooled Condenser	12-18*	8-15**	15-22*

* Sub-cooling must be increased by 2°F per 20 feet of vertical liquid line rise for R- 410A
** Superheat will increase with long suction line runs.

Correct an overcharged system by reducing the amount of refrigerant in the system to lower the sub-cooling.

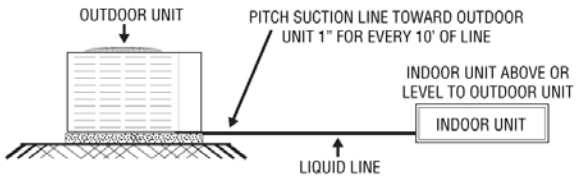
CAUTION

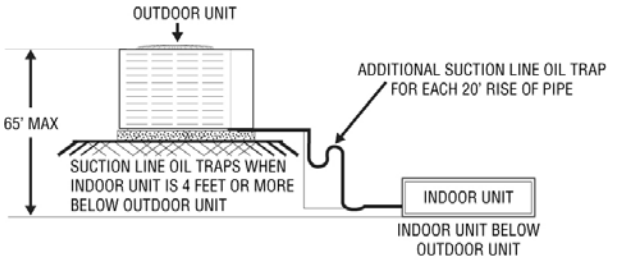
Refigerant overcharging leads to excess refrigerant in condenser coils resulting in elevated compressor discharge pressure. DO NOT OVERCHARGE !

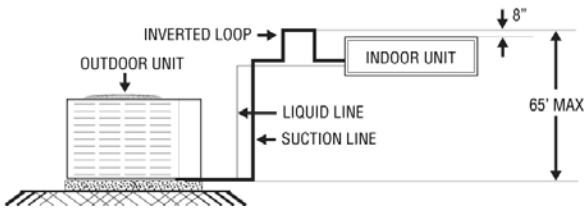
The system is **undercharged** if:
1. The superheat is too high **and**
2. The sub-cooling is too low.

• Correct an undercharged system by adding refrigerant to the system to reduce superheat and raise sub-cooling.
• If the sub-cooling is correct and the superheat is too high, the TXV may need adjustment to correct the superheat.

Elevation Limitations
See Table RP-1 for rise and run limitations. All lengths listed are in equivalent feet. An equivalent foot of the line includes the pressure drop of all valves, components, fittings and other pipes in the sections.







EVAPORATOR COIL

CAUTION

Evaporator coils are shipped under high pressure. Use extreme care and follow the installation instructions provided with the ev aporator coil to avoid personal injury.

The indoor coil is pressurized. The copper caps must be punctured to permit a gradual escape of the pressure prior to unsweating those caps. Immediately couple the tubing to the indoor unit to avoid exposing the coils to moisture. A properly sized filter drier is furnished in the condenser. When making solder connections, make sure dry nitrogen flows through the lines, when heating the copper, to prevent oxidization inside of the copper.

START-UP

General:

ONLY QUALIFIED, AUTHORIZED PERSONNEL SHOULD POWER ON, OR START-UP THIS EQUIPMENT.

Before starting up the equipment, building construction should be complete, and start-up personnel should:
• Have a working knowledge of general HVAC and mechanical commissioning procedures and practices.
• Be familiar with unit functions, features, optional unit accessories, and all control sequences.
• Have appropriate literature on hand for consultation.

⚠ CAUTION

Equipment operation during construction is not recommended. Construction site pollution can affect unit operation, and seriously degrade performance. Operation during construction will void all manufacturer's warranties.

Before the structure is occupied, the installation, and/or start-up personnel must take three essential steps:

1. Check-Out
2. Start-Up
3. Commissioning

Check-Out:
Equipment should be thoroughly checked for loose wiring, a free spinning blower wheel and well fitting access panels. Air handlers should not be operated without proper ductwork and access panels installed, except as required during start-up and air balancing.

1. Check all electrical connections to be sure they are tight.
2. Open all access panels, and remove all shipping screws, or restraints.
3. Clean out any debris that may be present.
4. Check wheel alignment, and tightness of fan drives.
5. Check bearing locking collars if provided and fan wheel set screws for tightness.
6. Turn fan wheels to assure free rotation.
7. Ensure electrical supply matches the unit nameplate.
8. Ensure condensate lines are correctly connected.
9. Check local codes for any special provisions.
10. Replace and/or close all access panels.

Procedures:

Note: Failure to adhere to the following start-up procedures will void all manufacturer warranties.

Install gauges, voltmeter and ammeter before start-up. Observe refrigerant pressures during initial operation. Note, and determine the cause of any excessive sound or vibration. Follow start-up procedures outlined below to start each piece of equipment.

Note: Completed factory test sheets are in the equipment literature packet shipped inside the unit. Factory run-test readings recorded on the test sheets may be helpful to reference during start-up.

⚠ WARNING

Do not alter factory wiring. Deviation from the supplied wiring diagram will void all warranties, and may result in equipment damage or personal injury. Contact the factory with wiring discrepancies.

Electric Heat Section Procedures:

1. Perform final visual inspection. Check all equipment ductwork and piping to verify that all work is complete. Improperly installed equipment or ductwork can affect readings.
2. Ensure that there is no construction debris in the unit.
3. Check the unit for external damage.
4. Note all accessories installed.
5. Install a filter of the proper size and type.
6. Check all terminal blocks, fuses, fuse blocks, and contactors for correctness.
7. Check all high and low voltage wiring connections for correctness, and tightness.
8. Check unit for correct incoming voltage per the data plate.
9. Turn the power on.
10. Turn on the first stage of heating

• Check amp draw of each element of each stage.
• Ensure blower started with electric heat.
• Check for temperature rise across heating section while all stages are on.
• If temperature rise is within range, turn all heating calls off.
• Check to see that blower stops.

Refrigerant Cooling Section Procedures:

1. Perform final visual inspection. Check all equipment, ductwork and piping to verify that all work is complete, and equipment is properly installed and mounted. Improperly installed equipment or ductwork can affect readings.
2. Perform condensing unit start-up checks in addition to these air handler checks according to the unit manufacturer's instructions.
3. Ensure that there is no construction debris in the unit.
4. Check the unit for external damage.
5. Install filter of the proper size and type.
6. Ensure that drain P-trap is installed.
7. Check all terminal blocks, fuses, fuse blocks, disconnect box, and contactors for correctness.
8. Check all high and low voltage wiring connections for tightness. Check unit for correct incoming voltage per the data plate.
9. Check the security of the locking system on all blower bearings.
10. Turn the power on.
11. Check and record ambient temperature.
12. Check for guaranteed off timers (GOT), and/or time delay relays (TDR).
13. Start the first step cooling circuit, and blower circuit.

Optional Equipment procedures:

If Modulating Hot Gas Reheat is equipped, additional installation steps are required.

1. Field installed piping is required.
2. The field supplied thermostat and humidistat must be wired to the reheat control as shown in the unit wiring diagram.
3. Verify that the condenser hot gas valve and reheat hot gas valve are wired as shown in the wiring diagram.
4. Verify that the Modulating Hot Gas Reheat system is working properly. Run for five minutes in the reheat mode and verify that the temperature of the supply air stream matches the reheat temperature set point.

Commissioning:

Air Balancing:
• High performance systems commonly have complex air distribution and fan systems. Unqualified personnel should not attempt to adjust fan operation, or air circulation, as all systems have unique operating characteristics. Professional air balance specialists should be employed to establish actual operating conditions, and to configure the air delivery system for optimal performance.

Water Balancing:
A hydronic specialist with a complete working knowledge of water systems, controls and operation must be employed to properly balance the entire system. Unqualified personnel should not attempt to manipulate temperatures, pressures, or flow rates, as all systems have

unique operating characteristics, and improper balancing can result in undesirable noises and operation.

Controls:
• A variety of controls and electrical accessories may be provided with the equipment.
• Identify the controls on each unit by consulting appropriate submittal or order documents, and operate according to the control manufacturer's instructions. If you cannot locate installation, operation or maintenance information for the specific controls, then contact your sales representative, or the control manufacturer for assistance.

OPERATION AND MAINTENANCE

General:
Immediately following unit startup, the air conditioning system requires a maintenance schedule to assure continued successful operation. A maintenance program similar to the example given below should be scheduled for routine maintenance of this equipment in order to provide efficient and reliable operation for the owner.

Maintenance Schedule:

One week after start-up:
• Check refrigerant charge. Evacuate and repair if leaking
• Check filters for cleanliness. Measure pressure loss if applicable. Replace if necessary.
• Check cycling of compressors, fans and valves. Correct unusual cycling.

Monthly:
• Check cleanliness of filters, and replace if necessary.
• Check cooling coil drain pan to assure proper drainage or correct.
• Inspect evaporator and condenser coils. Clean if dirty or obstructed in any way.

Quarterly:
• Check operation of heating and cooling sections.
• Check inlet and outlet air temperatures. Determine cause for abnormal changes.

Annually:
• Clean the condenser and evaporator coils with steam or a non-corrosive cleaner.
• Clean the drain line, "P" trap and condensate pan.
• Check refrigerant pressures and temperatures every spring and correct unusual readings.
• Check heating section every fall. Check all electrical connections for tightness and check heater elements for indications of overheating. Determine cause and replace elements if necessary.
• Inspect and clean unit interior at the beginning of each heating and cooling season and as operating conditions require.

Lubrication:
• All original motors and bearings are furnished with factory lubrication. They require no lubrication.

Blower Assembly:
• F1 air handlers are equipped with highly efficient forward curved fans. The blower wheel should be inspected periodically and cleaned of dust and debris. Clean blower wheels reduce electrical use, maintain capacity and reduce stress on the unit.
• To inspect and clean the blower, set thermostat to the "OFF" position. Turn the electrical power to the unit to the "OFF" position at the disconnect switch. Check set screw for tightness.

Coils:
Coils should be inspected and cleaned annually to ensure there is no obstruction to airflow. Dirty evaporator coils will eventually freeze up, and often result in a time consuming and expensive service call. Clean filters will help to prevent dirt from accumulating on the evaporator. The evaporator should be cleaned annually with a non-corrosive coil cleaning solution.

Heating:

Electric:
• Set thermostat in the heat mode; call for heat to engage all electric heat strips. Verify that electric heat operates correctly.

Heat Pump:
• Set thermostat in the heat mode; call for heat to engage the three-way valve and turn the heat pump mode on. Verify that the heat pump operates correctly.

Hot Water:
• Set thermostat in the heat mode; call for hot water valve to open. Verify that hot water valve opens with call for heat.

Filters:
• Open filter access door. Slide filters away from unit and inspect. Replace dirty filters with 20" X 20" X 1" filters.
• Ensure that the arrow points toward the blower in the direction of airflow. Filters should be checked every 30 days and replaced or cleaned as necessary.

⚠ CAUTION

Equipment should never be operated without filters.

Permanent type filters may be vacuumed and/or washed but should not be reinstalled until thoroughly dry. Most air filters are marked to indicate the direction of airflow, and this should be carefully noted when they are being installed.

⚠ CAUTION

Never turn a dirty filter to allo w airflow in the opposite direction.

The blower and motor bearings are permanently lubricated and do not require additional lubrication. It is recommended that the owner have available at least one set of replacement fuses of the size supplied with the original equipment.

⚠ IMPORTANT

Keep coils, blowers, and filters clean.

Service:
• In the event the unit is not functioning correctly and a service company is required, only a company with service technicians qualified and experienced in both heating and air conditioning should be permitted to service the systems in order to keep warranties in effect. The service tech may call the sales representative if assistance is required.

Note: Service technician must provide the model and serial number of the unit in all correspondence with AAON.

ALWAYS USE AAON SPECIFIED PARTS
To order parts from the AAON parts store online go to www.aaonparts.com.

REFRIGERANT PIPING

Note: This section is for information only and is not intended to provide all details required by the designer or installer of the refrigerant piping between the condensing unit and air handling equipment. AAON is not responsible for interconnecting refrigerant piping. Consult ASHRAE Handbook – Refrigeration and ASME Standards.

General:
• Piping from the condensing unit to the air handler is the responsibility of the installing contractor.
• Use only clean type "ACR" copper tubing that has been joined with high temperature brazing alloy.
• The pipe sizes must be selected to meet the actual installation conditions and not simply based on the connection sizes at the evaporator and/or condensing unit.
• Condensing units are provided with in-line shutoff valves on both the liquid and suction

lines. These should remain closed until the system is ready for start-up after piping and vacuuming.
• Piping should conform to generally accepted practices and codes.
• Upon completion of piping connection, the interconnecting piping and air handler MUST BE evacuated to 500 microns or less; leak checked and charged with R-410A refrigerant.

Determining Refrigerant Line size:
The piping between the condenser and low side must assure:
1. Minimum pressure drop, **and**
2. Continuous oil return, **and**
3. Prevention of liquid refrigerant slugging, or carryover

• Minimizing the refrigerant line size is favorable from an economic perspective, reducing installation costs, and reducing the potential for leakage. However, as pipe diameters narrow, pressure-reducing frictional forces increase.
• Excessive suction line pressure drop causes loss of compressor capacity and increased power usage resulting in reduced system efficiency. Excessive pressure drops in the liquid line can cause the liquid refrigerant to flash, resulting in faulty expansion valve operation and improper system performance. In order to operate efficiently and cost effectively, while avoiding malfunction, refrigeration systems must be designed to minimize both cost and pressure loss.

The pipe sizes must be selected to meet the actual installation conditions, and not simply based on the connection sizes at the evaporator and/or condensing unit.

Equivalent Line Length:
All line lengths discussed in this manual, unless specifically stated otherwise, are Equivalent Line Lengths. The frictional pressure drop through valves, fittings and accessories is determined by establishing the equivalent length of straight pipe of the same diameter. **Always use equivalent line lengths when calculating pressure drop**. Special piping provisions must be taken when lines are run underground, up vertical risers, or in excessively long line runs.

Liquid Line Sizing:
• When sizing the liquid line, it is important to minimize the refrigerant charge to reduce installation costs and improve system reliability. This can be achieved by minimizing the liquid line diameter. However, reducing the pipe diameter will increase the velocity of the liquid refrigerant, which increases the frictional pressure drop in the liquid line, and causes other undesirable effects such as noise. Maintaining the pressure in the liquid line is critical to ensuring sufficient saturation temperature, avoiding flashing upstream of the TXV, and maintaining system efficiency. Pressure losses through the liquid line due to frictional contact, installed accessories and vertical risers are inevitable. Maintaining adequate sub-cooling at the condenser to overcome these losses is the only method to ensure that liquid refrigerant reaches the TXV.
• Liquid refrigerant traveling upwards in a riser will lose head pressure. If the evaporator section is below the condenser, and the liquid line does not include risers, the gravitational force will increase the pressure of the liquid refrigerant. This will allow the refrigerant to withstand greater frictional losses without the occurrence of flashing prior to the TXV.
• A moisture-indicating sight glass may be installed in the liquid line by special order to indicate the occurrence of premature flashing or moisture in the line. The sight glass should not be used to determine if the system is properly charged. **Use temperature and pressure measurements to determine liquid sub-cooling, not the sight glass.**

Liquid Line Routing:
Care should be taken with vertical risers. When the system is shut down, gravity will pull liquid down the vertical column, and back to the condenser when it is below the evaporator. This could potentially result in compressor flooding. A check valve can be installed in the liquid line where the liquid column rises above the condenser to prevent this. The liquid line is typically pitched along with the suction line, or hot gas line, in the direction of the compressor to minimize the complexity of the configuration.

Liquid Line Insulation:
When the liquid line is routed through regions where temperature losses are expected, no insulation is required, as this may provide additional sub-cooling to the refrigerant. When routing the liquid line through high temperature areas, insulation of the line is appropriate to avoid loss of sub-cooling through heat gain.

Liquid Line Guidelines:
• In order to ensure liquid at the TXV, frictional losses must not exceed available sub-cooling. A commonly used guideline to consider is a system design with pressure losses due to friction through the line not to exceed a corresponding 1-2°F change in saturation temperature.
• If the velocity of refrigerant in the liquid line is too great, it could cause excessive noise or piping erosion. The recommended maximum velocities for liquid lines are 100 fpm from the condenser to a receiver tank when used, to discourage fluid backup, and 300 fpm from receiver tank to the evaporator to minimize valve induced liquid hammer.

Liquid Line Accessories:
The total length equivalent of pressure losses through valves, elbows and fittings must be considered when adding additional components in the field. It is a good practice to utilize the fewest elbows that will allow the mating units to be successfully joined.

Suction Line Sizing:
The suction line is more critical than the liquid line from a design and construction standpoint. More care must be taken to ensure that adequate velocity is achieved to return oil to the compressor at minimum loading conditions. However, reducing the piping diameter to increase the velocity at minimal load can result in excessive pressure losses, capacity reduction, and noise at full load.

Suction Line Routing:
• Pitch the suction line in the direction of flow (about 1 ft. per 100 ft of length) to maintain oil flow towards the compressor, and keep it from flooding back into the evaporator. Crankcase heaters are provided to keep any condensed refrigerant that collects in the compressor from causing damage or wear. Make sure to provide support to maintain suction line positioning, and insulate completely between the evaporator and condensing unit.
• It is important to consider part load operation when sizing suction lines. At minimum capacity, refrigerant velocity may not be adequate to return oil up the vertical riser. Decreasing the diameter of the vertical riser will increase the velocity, but also the frictional loss. A double suction riser can be applied in this situation. The double suction riser is designed to return oil at minimum load while not incurring excessive frictional losses at full load. The double suction riser consists of a small diameter riser in parallel with a larger diameter riser, and a trap at the base of the large riser. At minimum capacity, refrigerant velocity is not sufficient to carry oil up both risers, and it collects in the trap, effectively closing off the larger diameter riser, and diverting refrigerant up the small riser where velocity of the refrigerant is sufficient to maintain oil flow. At full load, the mass flow clears the trap of oil, and refrigerant is carried through both risers. The smaller diameter pipe should be sized to return oil at minimum load, while the larger diameter pipe should be sized so that flow through both pipes provides acceptable pressure drop at full load.

Suction Line Insulation:
The entire suction line should be insulated. This prevents condensation from forming on the line, and reduces any potential loss in capacity associated with heat gain.

Suction Line Guidelines:
• For proper performance, suction line velocities less than a 4000 fpm maximum are recommended. The minimum velocity required to return oil is dependent on the pipe diameter; however, a general guideline of 1000 fpm minimum may be applied.
• In a fashion similar to the liquid line, a common guideline to consider is a system design with pressure losses due to friction through the line not to exceed a corresponding 1-2°F change in saturation temperature.
• At points where small pipe size can be used to provide sufficient velocity to return oil in vertical

risers at part loads, greater pressure losses are incurred at full loads. This can be compensated for by over sizing the horizontal runs and vertical drop sections. This will however require additional refrigerant charge.
• If the job requirements specify suction accumulators, they must be separately purchased and installed.

Hot Gas Reheat:
• The AAON modulating hot gas reheat system diverts hot discharge gas from the condenser to the air handling unit through the hot gas line. **Field piping between the condensing unit and the air handling unit is required.**
• The line delivers the hot discharge gas to the reheat coil and/or the hot gas bypass valve, so it is sized as a discharge line.
• Discharge lines should be sized to ensure adequate velocity of refrigerant to ensure oil return, avoid excessive noise associated with velocities that are too high, and to minimize efficiency losses associated with friction.
• Pitch the hot gas line in the direction of flow for oil return.
• When installing hot gas reheat risers, a drip leg must be provided at the lowest point in the system. The drip leg must be vertical, its diameter should be the same as the diameter of the riser, and it should be 1 foot long. Run a drip line, using 1/8 inch capillary tube, 10 feet in length, from the drip leg to the suction line. Connect the drip line a minimum of 1-inch above the bottom of the drain leg.
• Insulate the entire length of the hot gas line with a minimum 1-inch thick Armaflex insulation.

Hot Gas Reheat Guidelines:
• Maintain velocities below a maximum of 3500 fpm. A general minimum velocity guideline is 2000 fpm.

Predetermined Line Sizes:
• To aid in line sizing and selection, AAON has predetermined line sizes for the liquid and suction lines in comfort cooling applications.
• In order to generate this information, the following cycle assumptions are made: Saturated suction temperature = 50°F, Saturated condensing temperature = 125°F, Sub-cooling = 10°F, Superheat = 15°F.
• The liquid lines have been chosen to maintain velocities between 100 and 350 fpm. The suction line diameters are selected to limit velocities to a 4000 fpm maximum, while a minimum velocity restriction is imposed by the ability to entrain oil up vertical suction risers (ASHRAE Handbook - Refrigeration).
• Acceptable pressure loss criteria are applied to each of the lines: The total equivalent length of the liquid line available is determined such that 3°F of liquid sub-cooling remain at the TXV. This includes the pressure losses in horizontal and vertical sections, accessories, elbows, etc.
• Recall that the available sub-cooling for the cycle is assumed as 10°F. To maintain at least 3°F sub-cooling as a factor of safety to avoid flashing at the TXV, we consider a maximum pressure loss equivalent to a 7°F change in saturation temperature. Pressure losses in the suction line are not to exceed 2°F.

When to use predetermined line sizing:
The line sizes presented are not the only acceptable pipe diameters, they are however appropriate for general comfort cooling applications, and satisfy common job requirements. Examine the conditions, assumptions, and constraints used in the generation of the predetermined pipe diameters to ensure that this method is applicable to a particular case. Do not assume that these line sizes are appropriate for every case. Consult ASHRAE Handbook – Refrigeration for generally accepted system practices.

How to use predetermined line sizing:
• First, read the previous section entitled *(When to use predetermined line sizing)* to decide if this method is applicable.
• Next, consult TABLE RP-1 for pipe diameters.
• Examine Figure RP-1 to determine the acceptable line dimensions associated with the pipe diameters determined in TABLE RP-1. The figure is shown as total available riser height versus total equivalent line length for the liquid line. This curve identifies a region of acceptable piping configuration when the predetermined line sizes are selected for any model in the table. A

piping configuration above the curve falls outside the assumptions used to determine the line size and will result in a loss of sub-cooling, and additional pressure losses in the suction and hot gas bypass lines.

• The total equivalent line length definition includes the height of vertical rise, pressure drop through elbows and accessories, and horizontal line length, so elbows, accessories and vertical rise must be considered when determining horizontal length available from the total equivalent line length.

• Figure RP-1 is presented in terms of the liquid line, but it assumes that the line lengths for the suction and hot gas bypass are similar, as these lines will commonly be routed together to minimize the space and cost required for split system installation.

TABLE RP-1:
Predetermined Line sizes for F1 & CB matched sets with two step compressors and R-410A

Model	Connection Sizes		Predetermined Line Size		
	Liquid	Suction	Liquid	Suction	HGRH**
CB-024	3/8 inch	3/4 inch	3/8 inch	3/4 inch	3/8 inch
CB-036	3/8 inch	3/4 inch	3/8 inch	3/4 inch	1/2 inch
CB-048	3/8 inch	7/8 inch	3/8 inch	7/8 inch	1/2 inch
CB-060	3/8 inch	7/8 inch	1/2 inch	7/8 inch	1/2 inch

** Hot Gas Reheat line

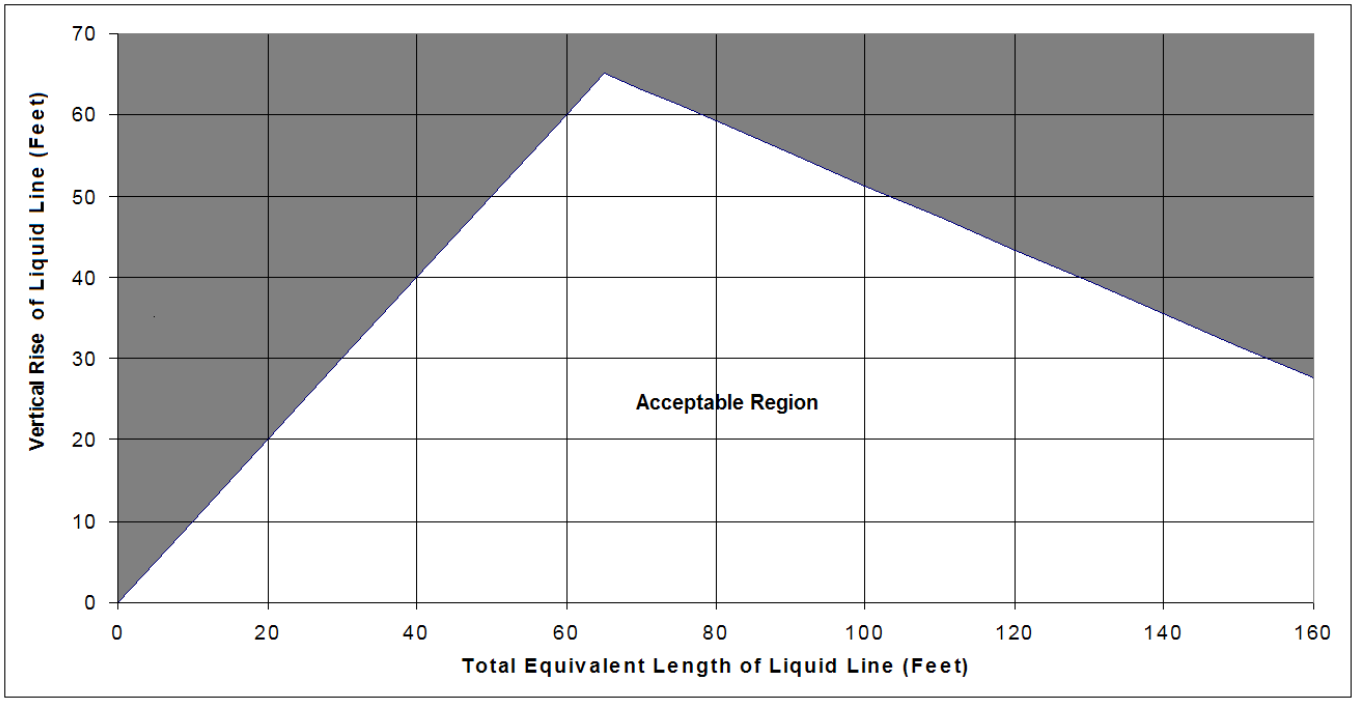


FIGURE RP-1. Riser height versus total equivalent line length for R-410A split system applications with two-step compressor CB-024 through CB-060 units. The region of acceptable riser height is the lighter area. Select the corresponding predetermined line size from TABLE RP-1 above.

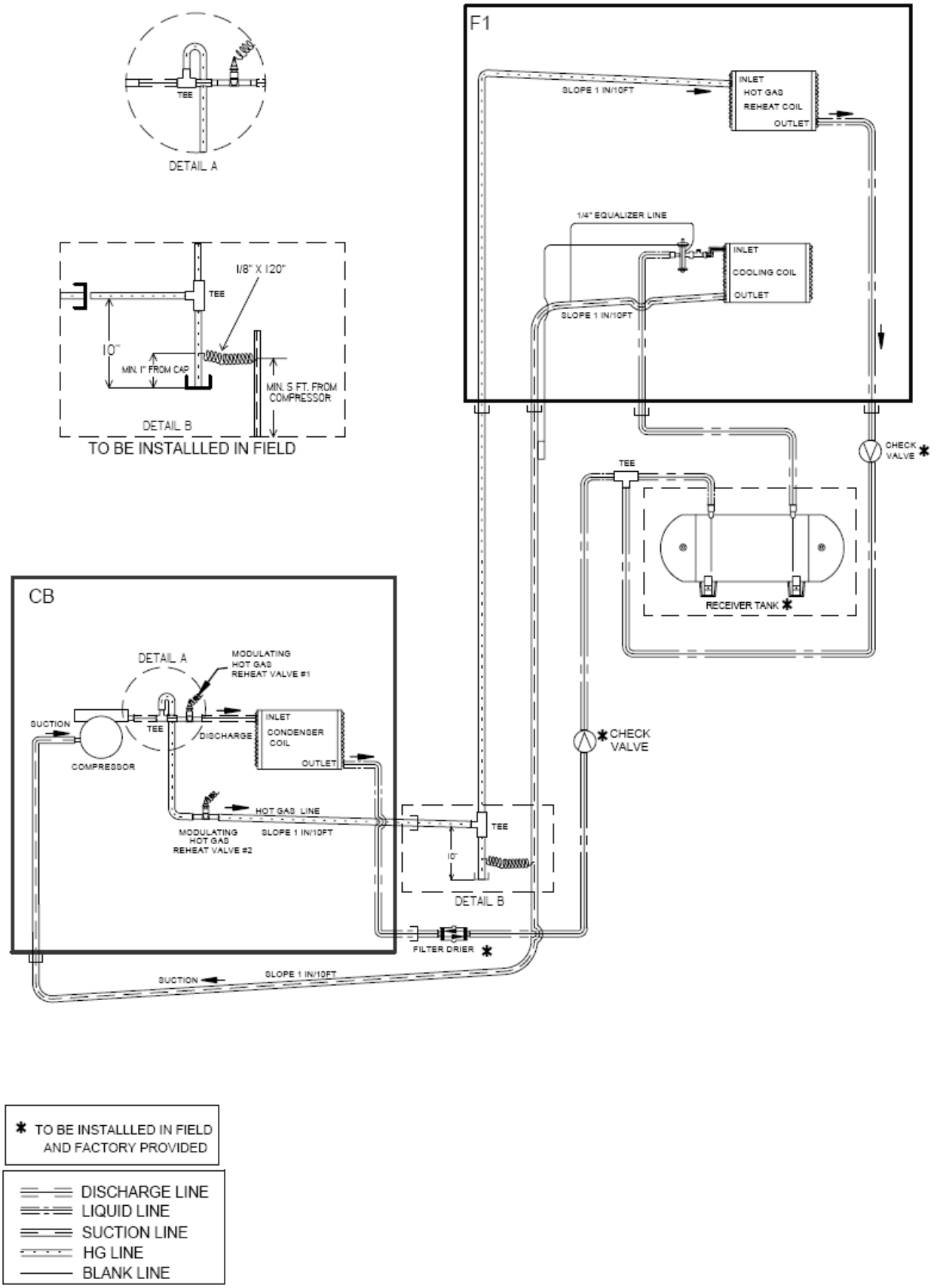


FIGURE RP-2. HOT GAS REHEAT PIPING DIAGRAM WITH AIR HANDLER ABOVE CONDENSING UNIT.

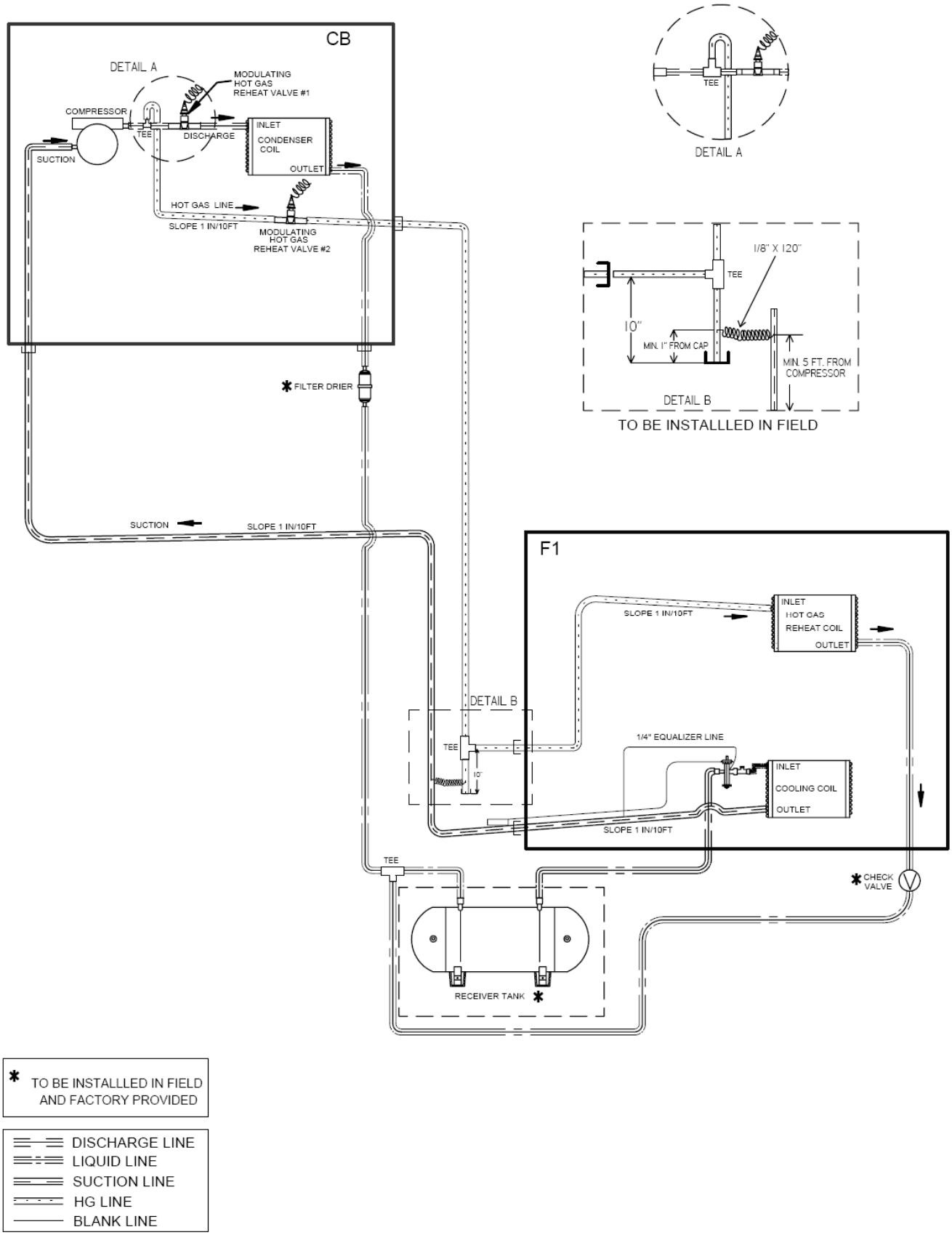


FIGURE RP-3. HOT GAS REHEAT PIPING DIAGRAM WITH AIR HANDLER BELOW CONDENSING UNIT.

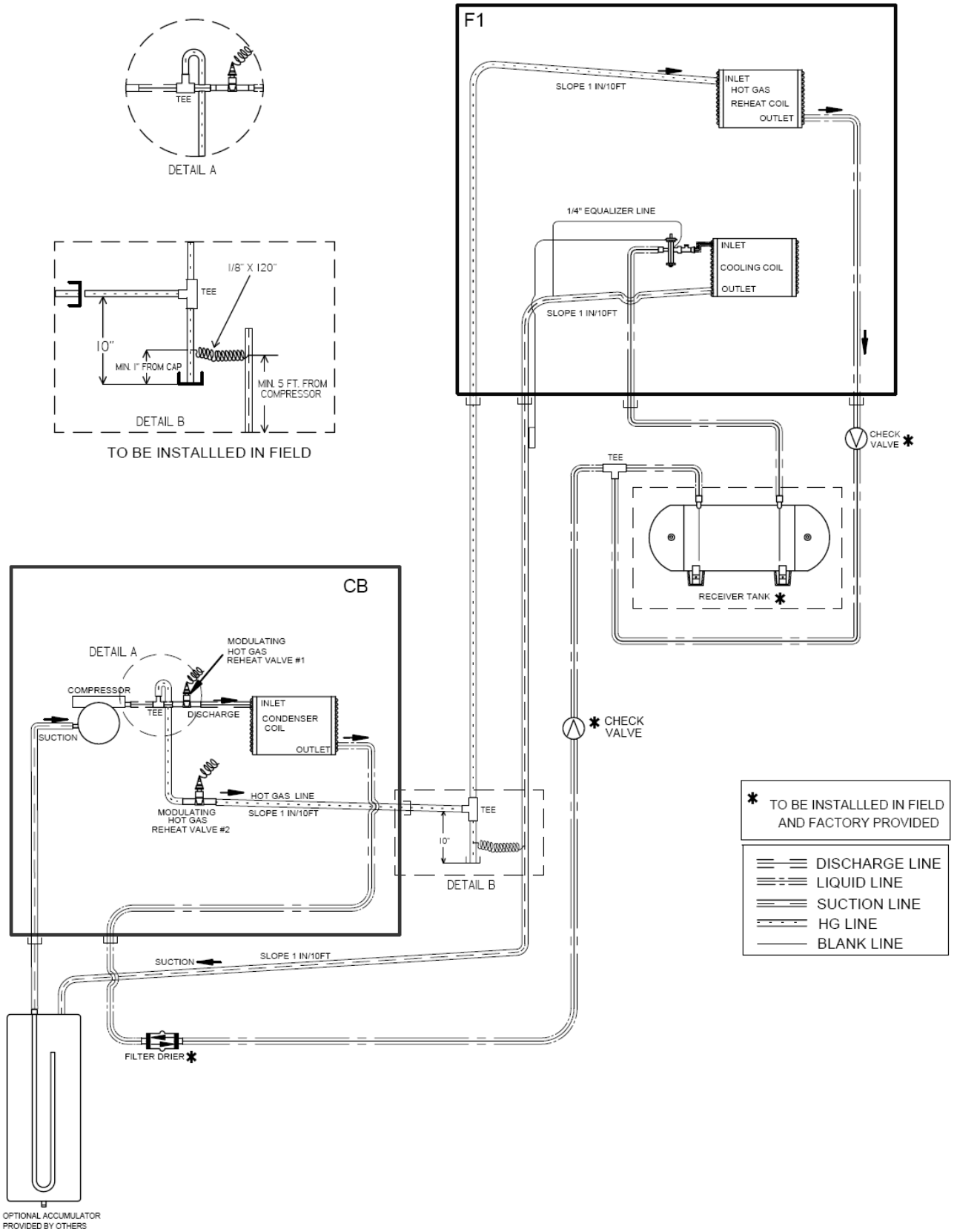


FIGURE RP-4. HOT GAS REHEAT PIPING DIAGRAM WITH AIR HANDLER ABOVE CONDENSING UNIT & OPTIONAL ACCUMULATOR.

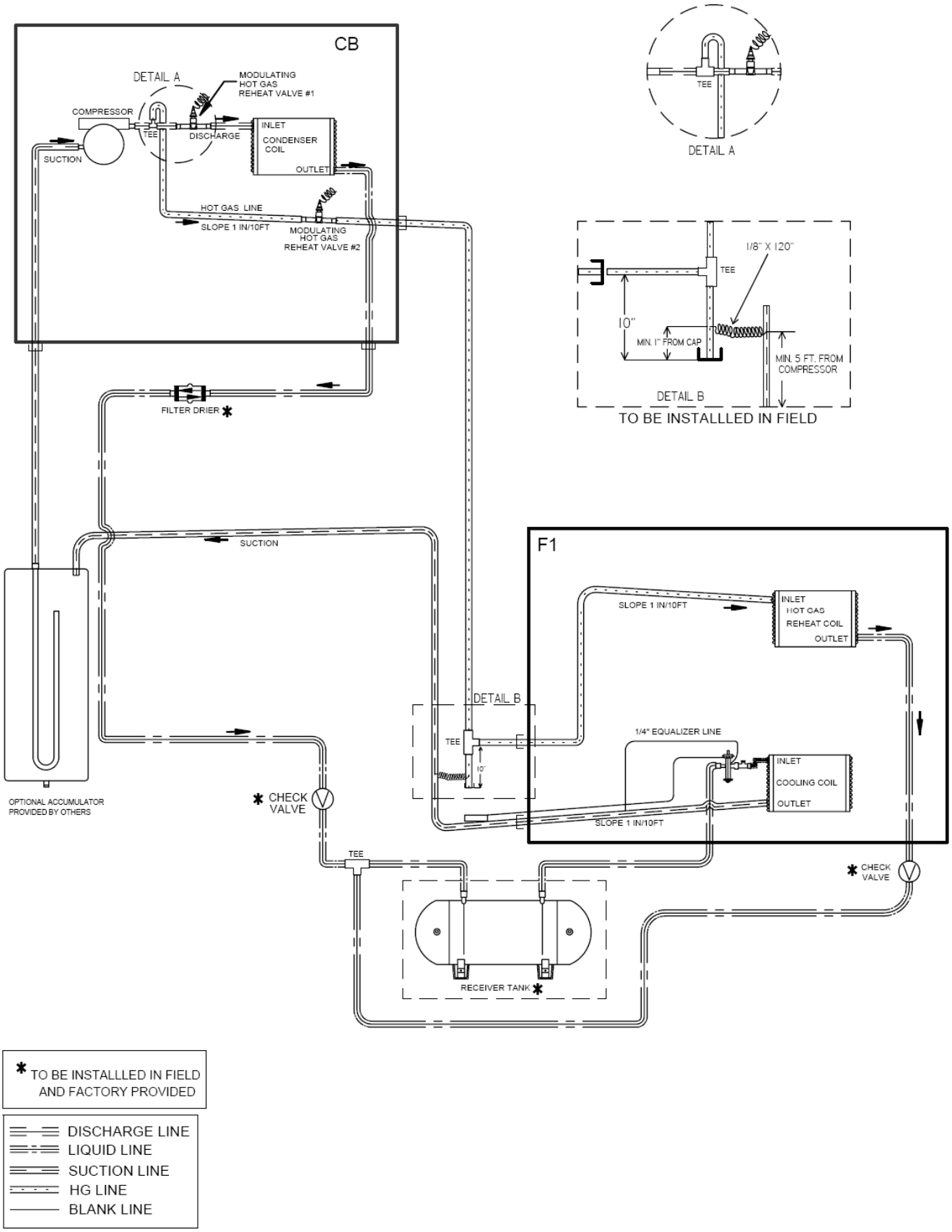


FIGURE RP-5. HOT GAS REHEAT PIPING DIAGRAM WITH AIR HANDLER BELOW CONDENSING UNIT & OPTIONAL ACCUMULATOR.

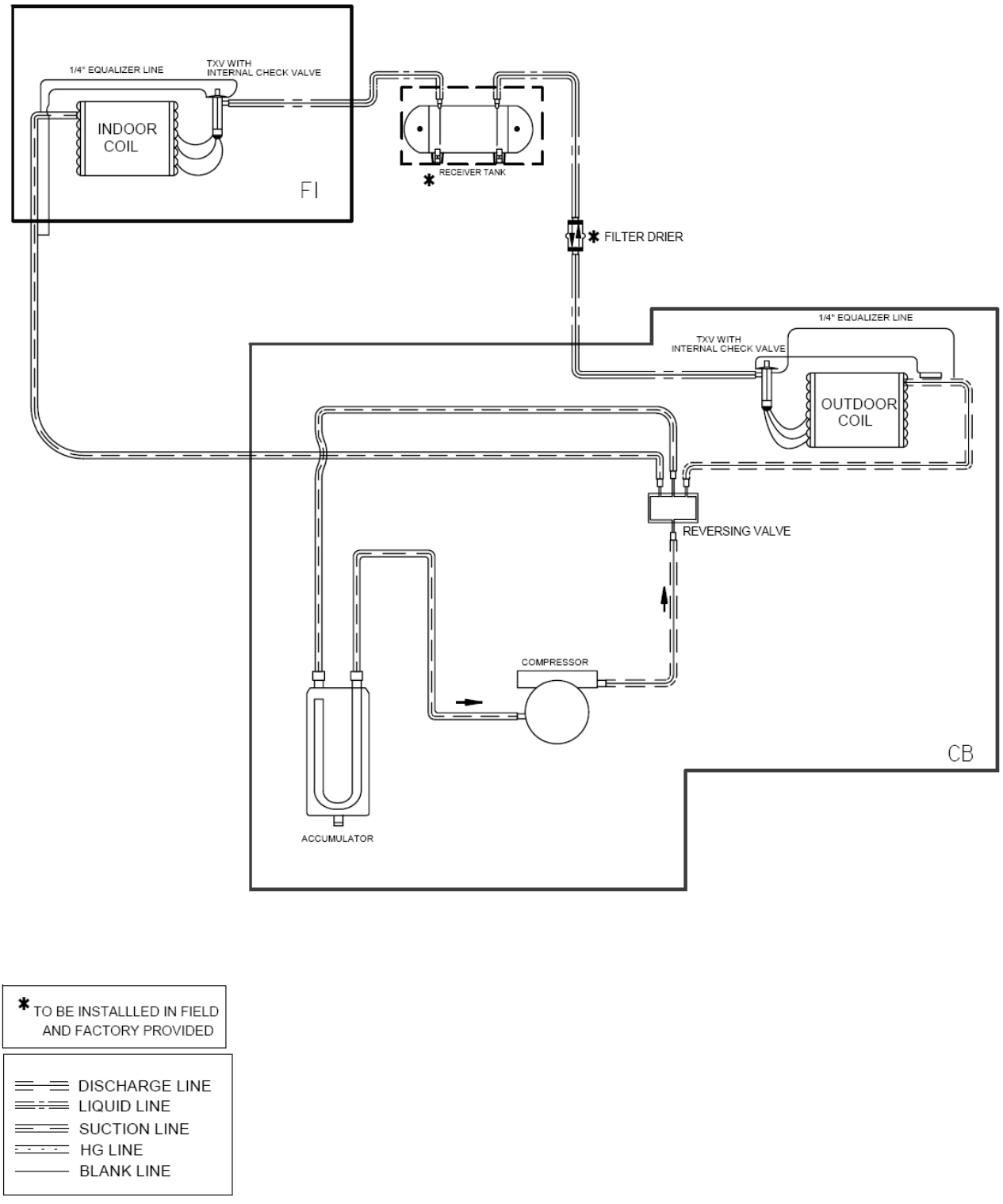


FIGURE RP-6. HEAT PUMP PIPING WITH INDOOR UNIT ABOVE OUTDOOR UNIT

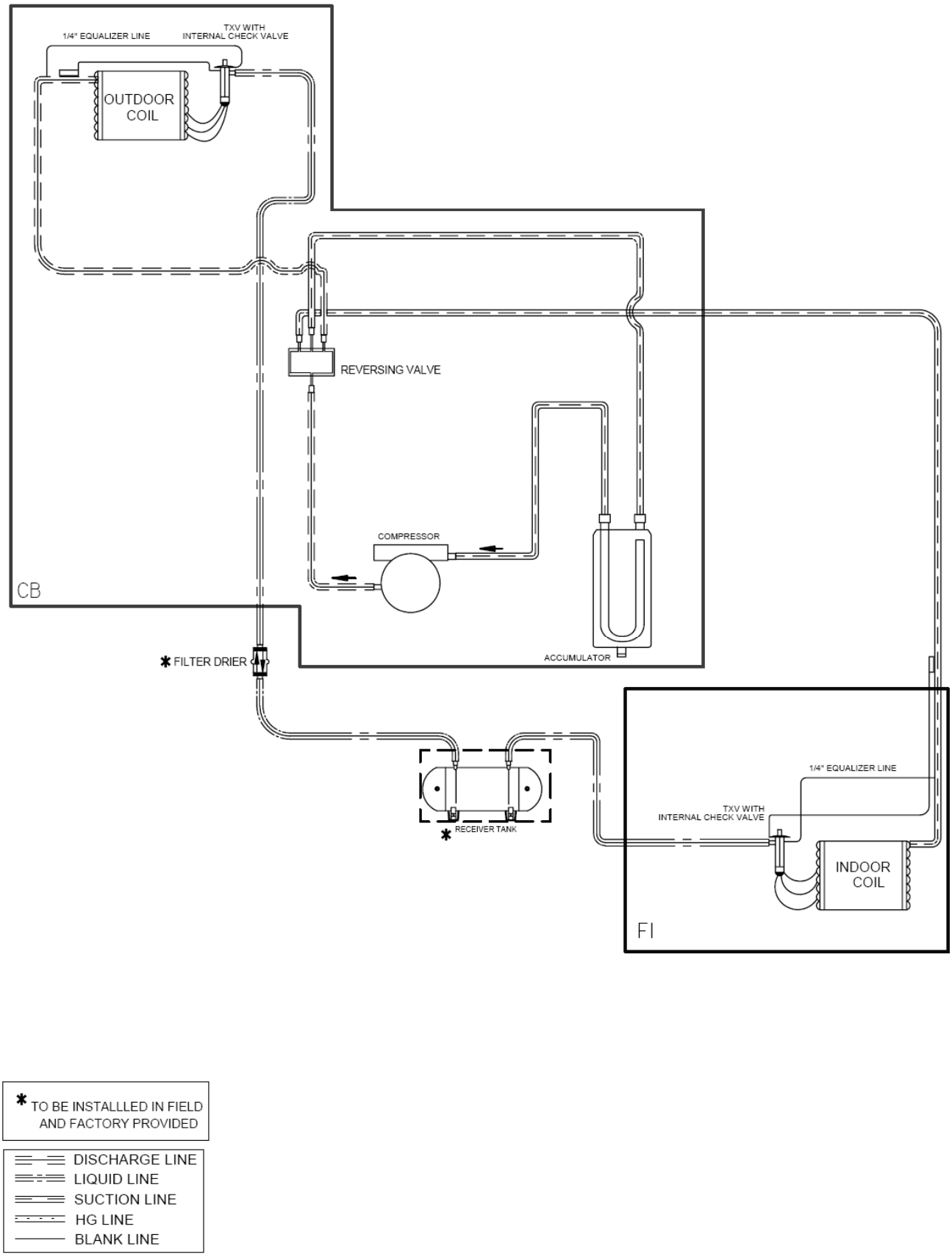


FIGURE RP-7. HEAT PUMP PIPING WITH OUTDOOR UNIT ABOVE INDOOR UNIT

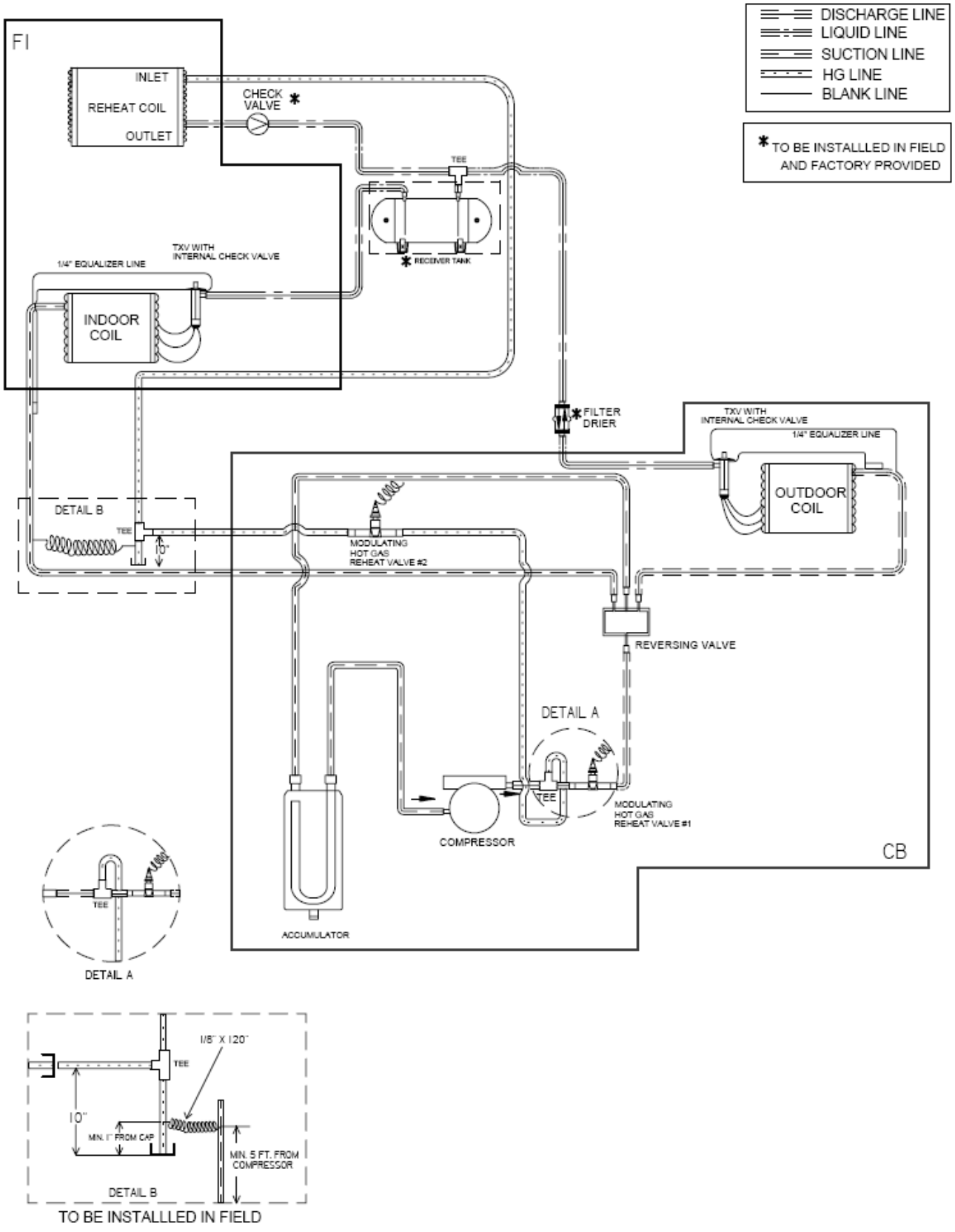


FIGURE RP-8. HEAT PUMP PIPING WITH REHEAT & INDOOR UNIT ABOVE OUTDOOR UNIT

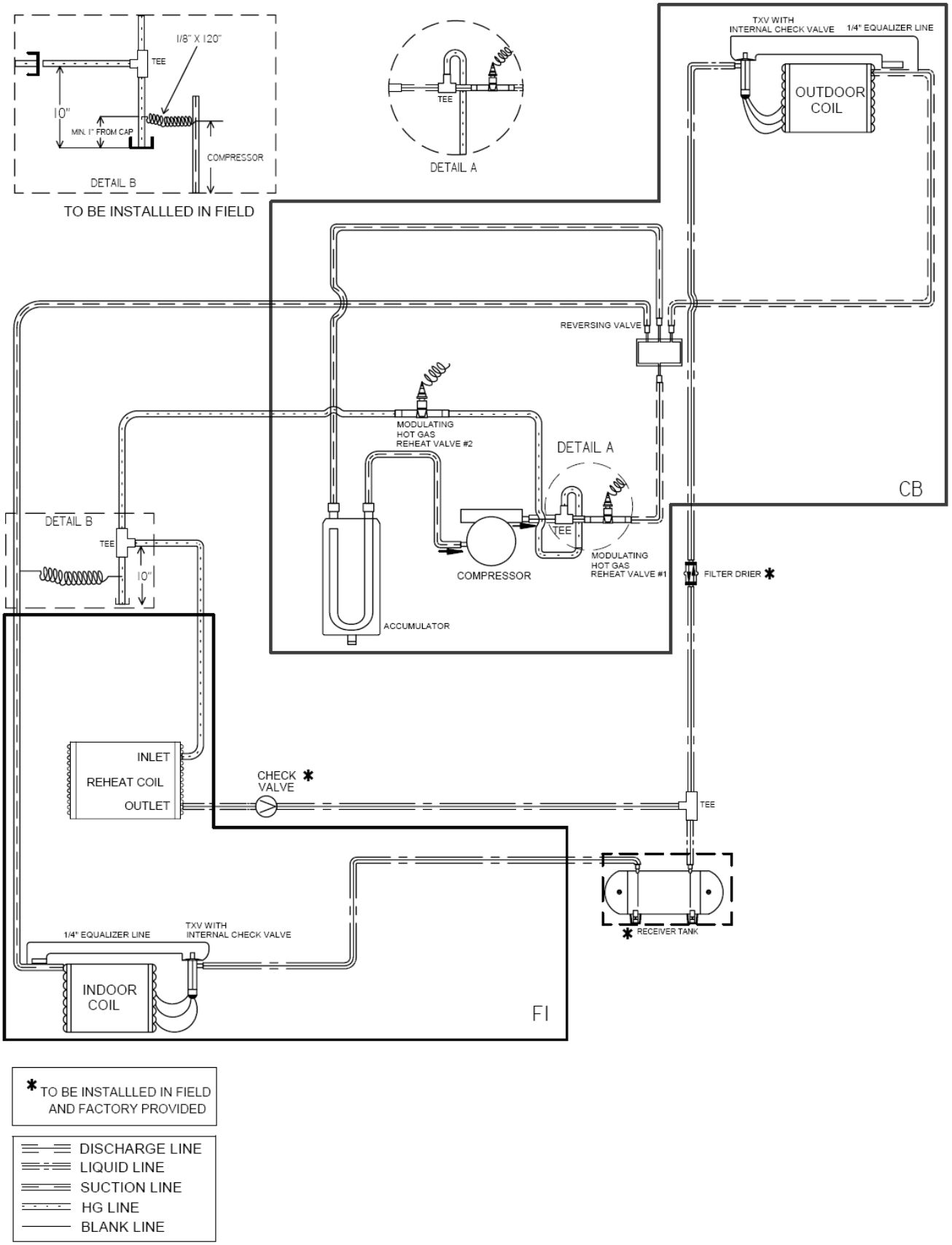


FIGURE RP-9. HEAT PUMP PIPING WITH REHEAT & OUTDOOR UNIT ABOVE INDOOR UNIT

THERMOSTAT INSTALLATION AND WIRING

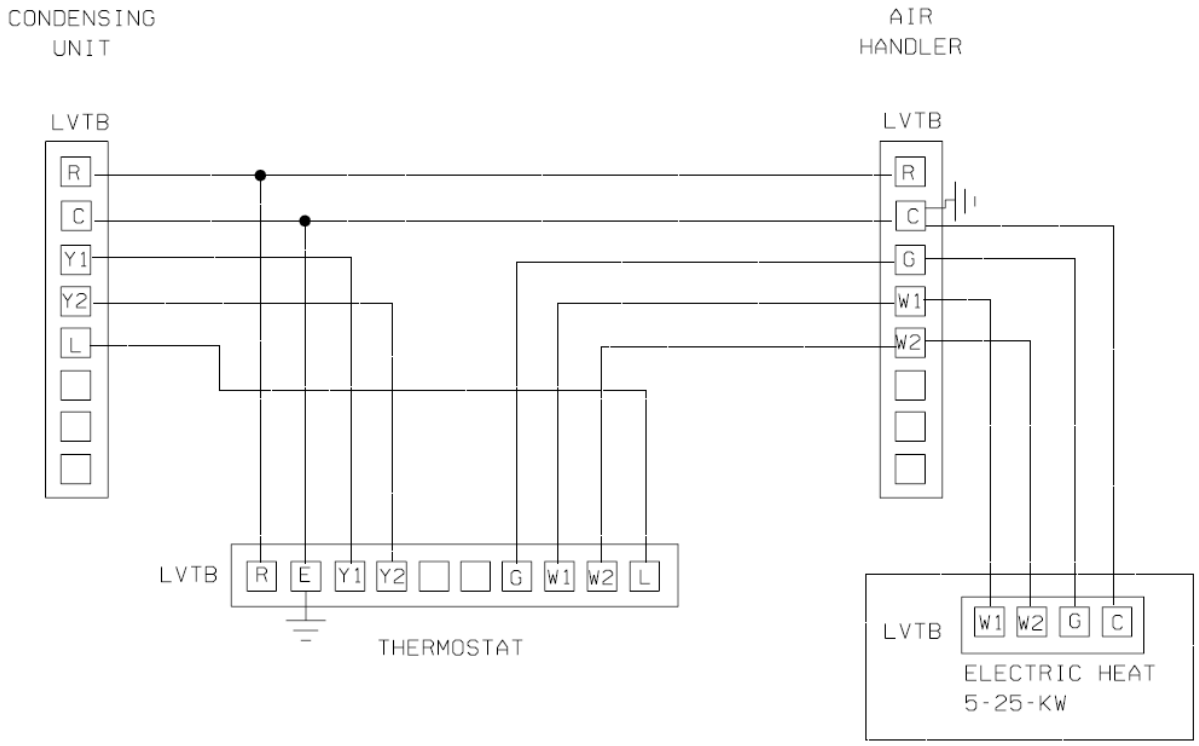


FIGURE T-1: 2 STAGE COOLING WITH ELECTRIC HEAT

THERMOSTAT INSTALLATION AND WIRING cont.

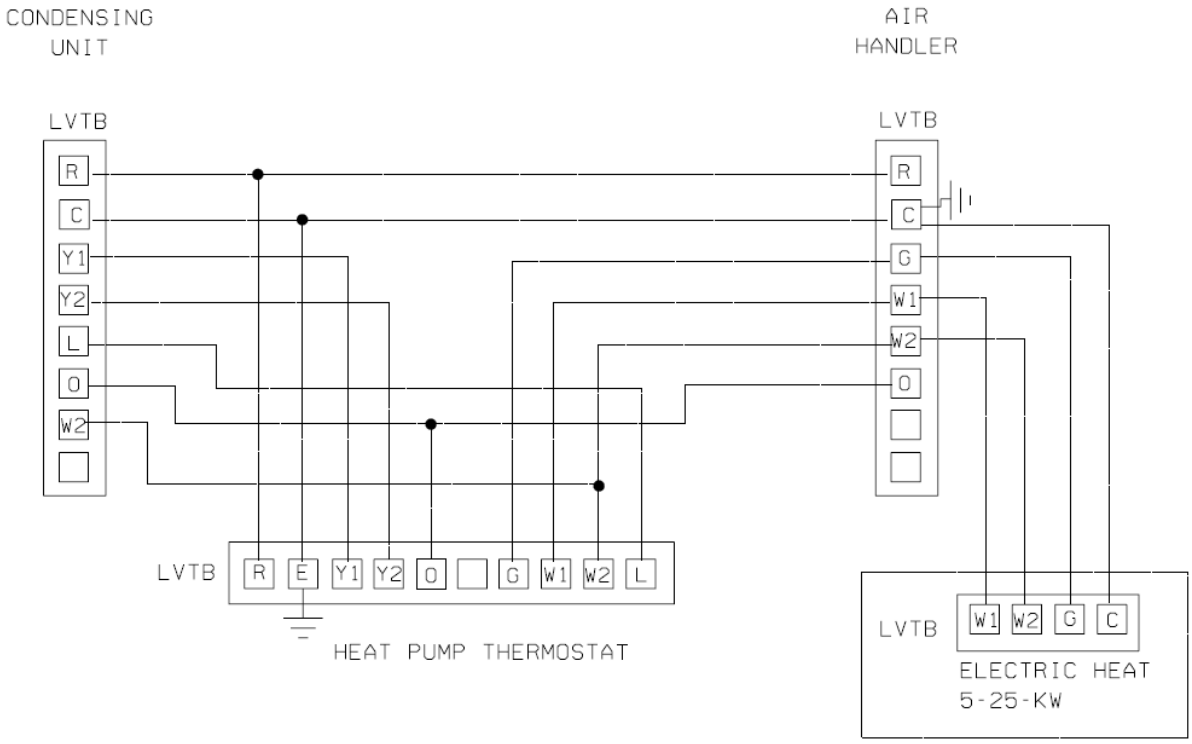


FIGURE T-2: 2 STAGE COOLING WITH HEAT PUMP AND ELECTRIC HEAT

THERMOSTAT INSTALLATION AND WIRING cont.

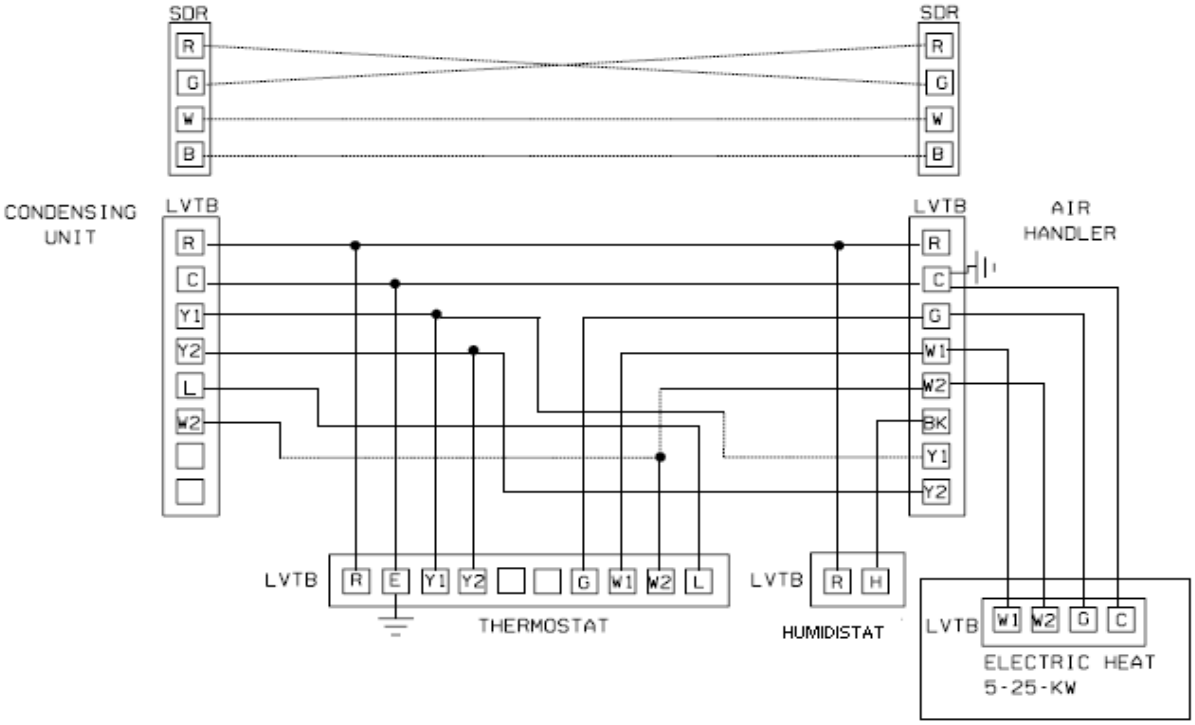


FIGURE T-3: 2 STAGE COOLING AND ELECTRIC HEAT WITH HOT GAS REHEAT, AND HUMIDISTAT

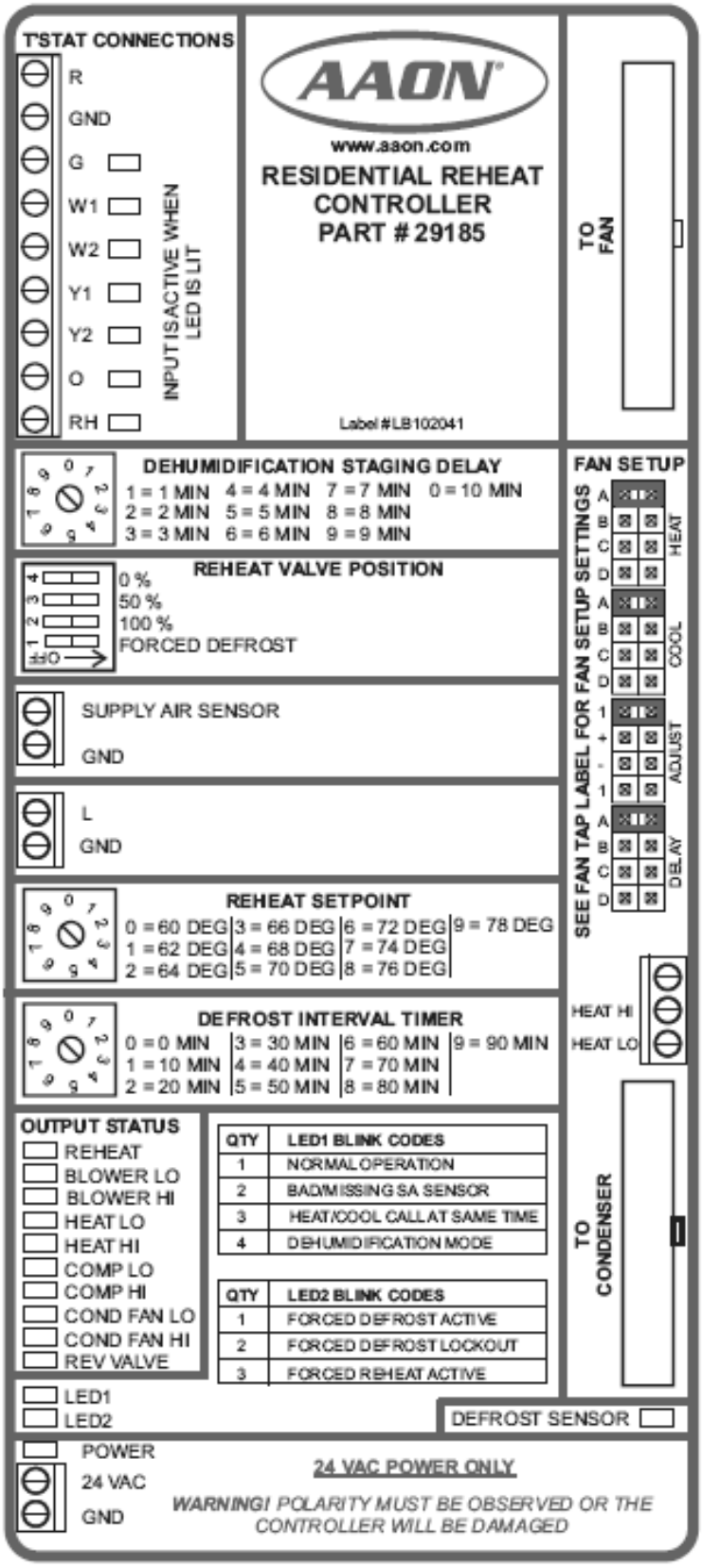


FIGURE T-4 : MAIN CONTROL BOARD FOR UNITS EQUIPPED WITH MODULATING HOT GAS REHEAT.

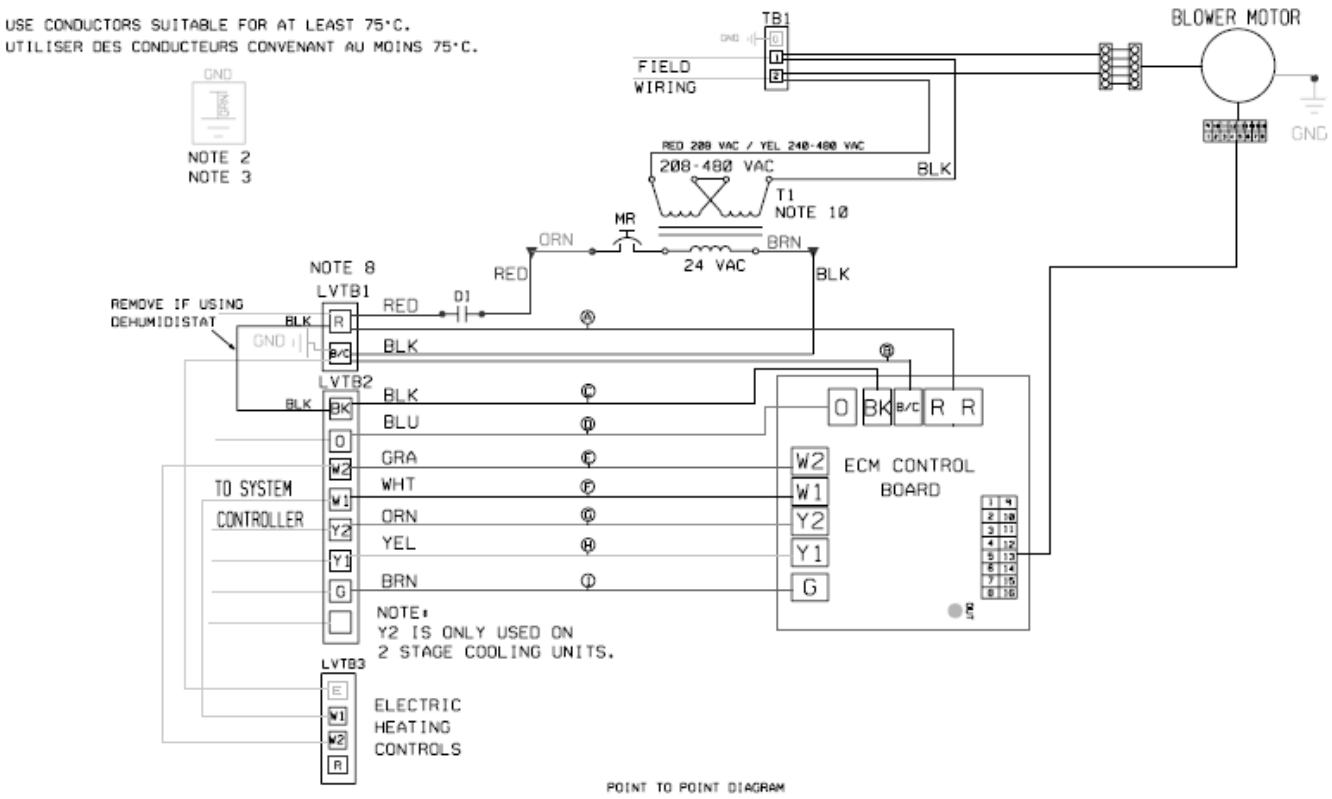
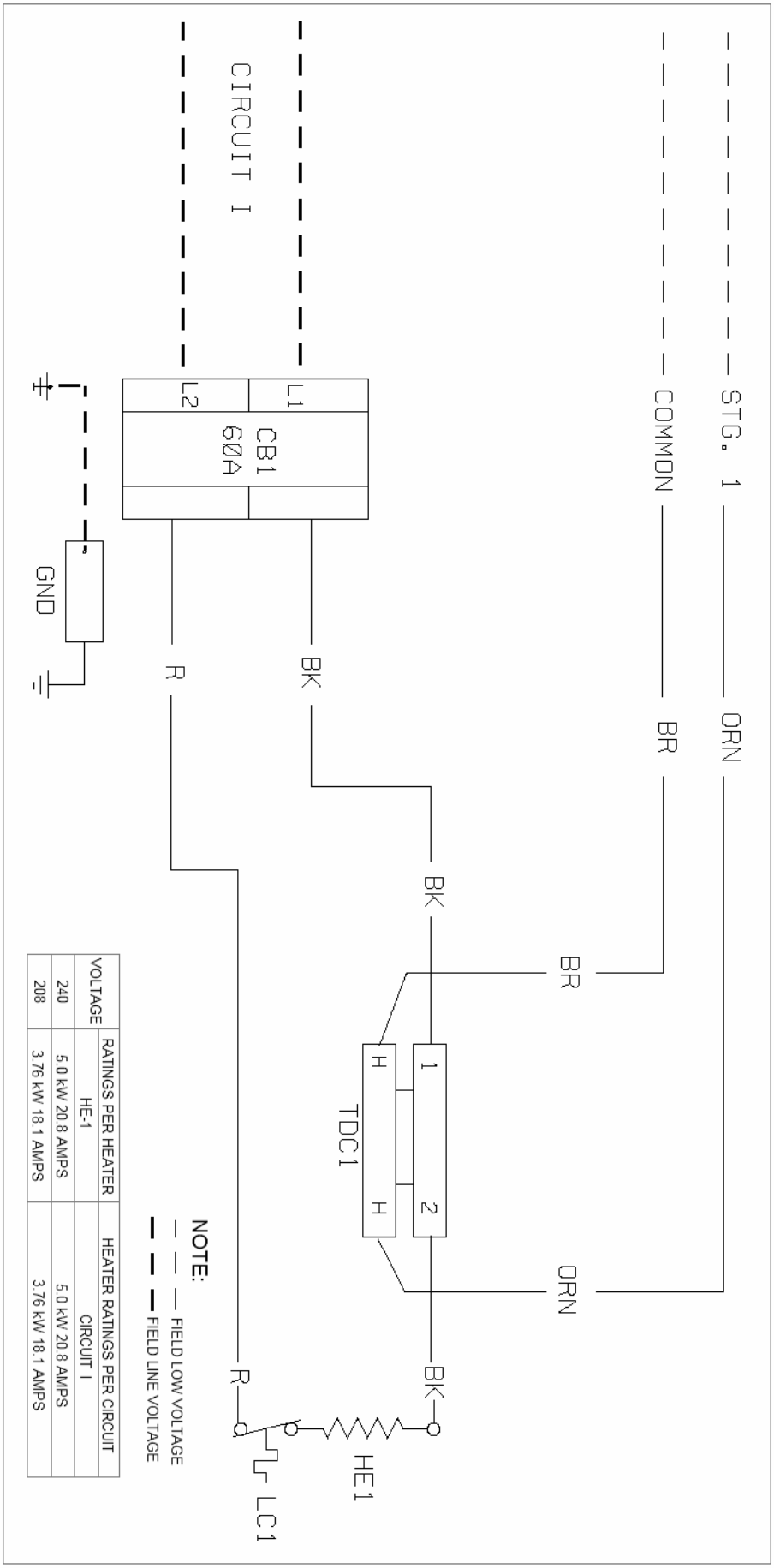


FIGURE T-5 : FIELD WIRING FOR F1. ELECTRIC HEATING CONNECTIONS ARE MADE AT LVTB3.



VOLTAGE	RATINGS PER HEATER	HEATER RATINGS PER CIRCUIT
	HE-1	CIRCUIT I
240	5.0 kW 20.8 AMPS	5.0 kW 20.8 AMPS
208	3.76 kW 18.1 AMPS	3.76 kW 18.1 AMPS

FIGURE T-6 : 5KW ELECTRIC HEAT

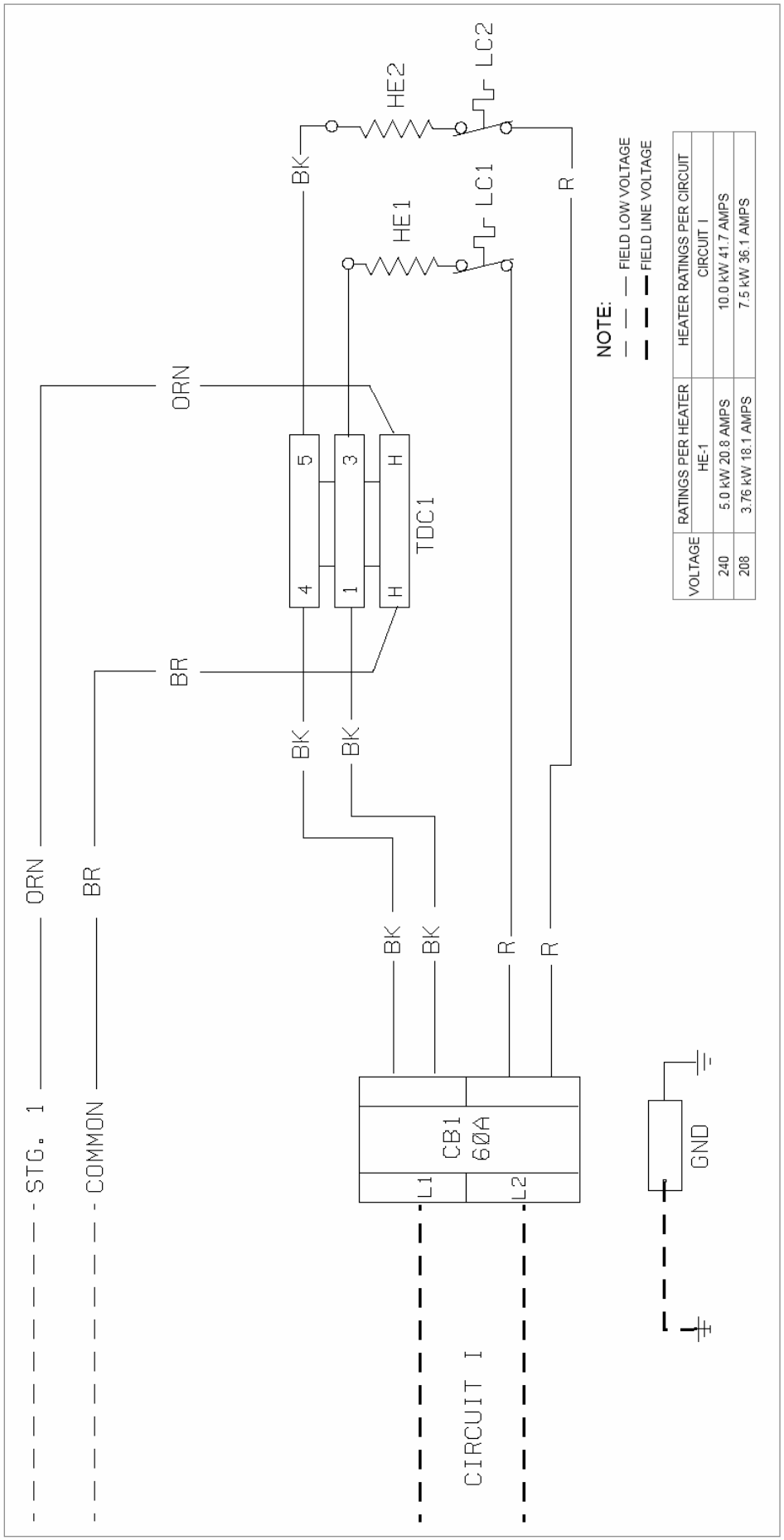
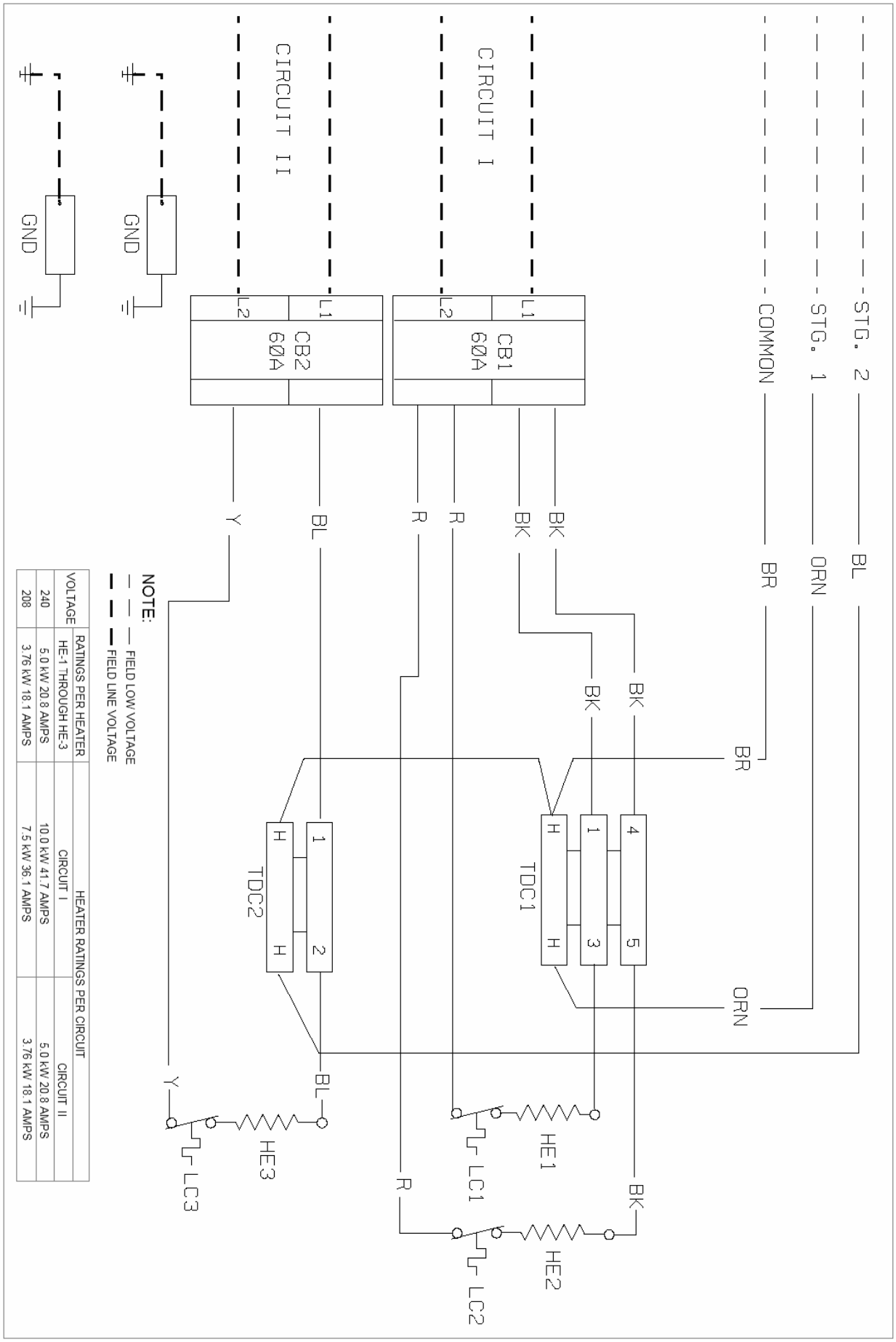
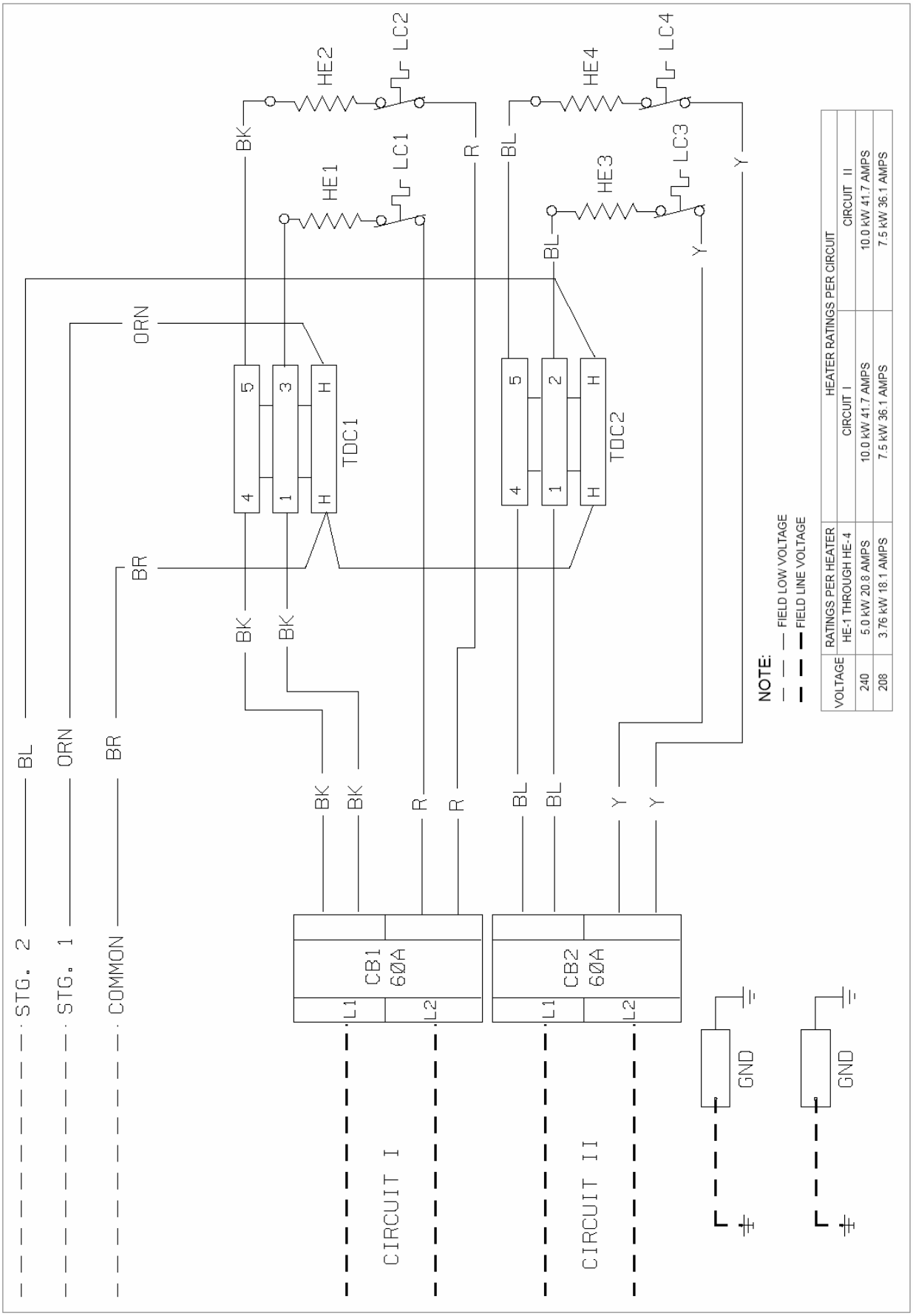


FIGURE T-7 : 10 KW ELECTRIC HEAT



VOLTAGE	RATINGS PER HEATER	HEATER RATINGS PER CIRCUIT	
	HE-1 THROUGH HE-3	CIRCUIT I	CIRCUIT II
240	5.0 kW 20.8 AMPS	10.0 kW 41.7 AMPS	5.0 kW 20.8 AMPS
208	3.76 kW 18.1 AMPS	7.5 kW 36.1 AMPS	3.76 kW 18.1 AMPS

FIGURE T-8 : 15 KW ELECTRIC HEAT



VOLTAGE	RATINGS PER HEATER	HEATER RATINGS PER CIRCUIT	
	HE-1 THROUGH HE-4	CIRCUIT I	CIRCUIT II
240	5.0 kW 20.8 AMPS	10.0 kW 41.7 AMPS	10.0 kW 41.7 AMPS
208	3.76 kW 18.1 AMPS	7.5 kW 36.1 AMPS	7.5 kW 36.1 AMPS

FIGURE T-9 : 20 KW ELECTRIC HEAT

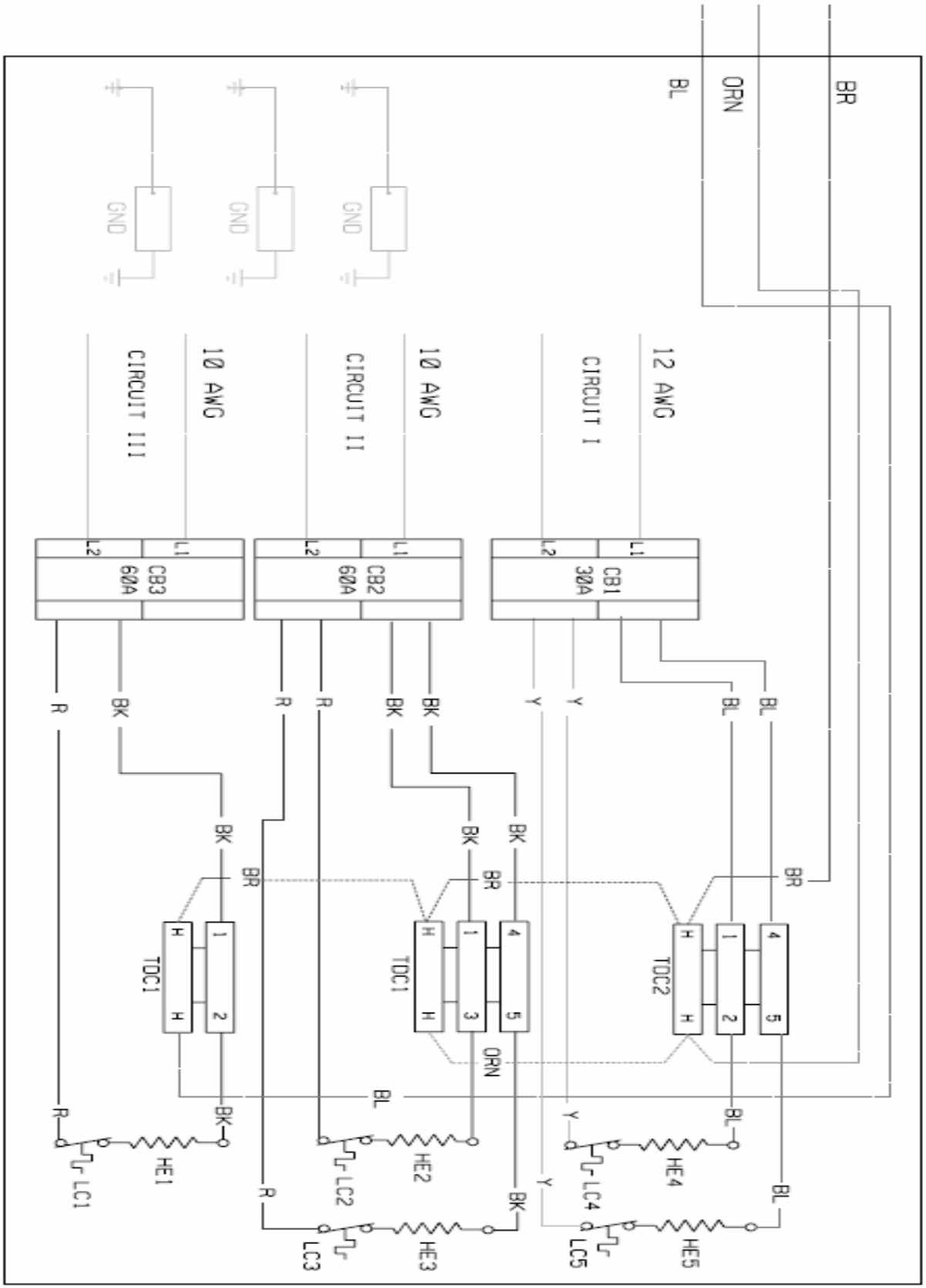


FIGURE T-10 : 25 KW ELECTRIC HEAT

F1 STARTUP FORM

DATE:_____

JOB NAME:_____

ADDRESS:_____ MODEL No:_____

CITY, STATE:_____ SERIAL No:_____

START-UP CONTRACTOR:_____ TAG:_____

PRE START-UP CHECKLIST

Installing contractor shall verify the following items (cross out items that do not apply).

1. Is there any visible shipping damage?_____ Yes ☐ No ☐
2. Is the unit installation level?_____ Yes ☐ No ☐
3. Are the unit clearances adequate for service and operation?_____ Yes ☐ No ☐
4. Have all electrical connections been tested for tightness?_____ Yes ☐ No ☐
5. Does the electrical service correspond to the unit nameplate?_____ Yes ☐ No ☐
6. Has the overcurrent protection been tested for tightness?_____ Yes ☐ No ☐
7. Have all set screws on fans been tightened?_____ Yes ☐ No ☐
8. Does the fan rotate freely?_____ Yes ☐ No ☐
9. Is all copper tubing isolated so that it does not rub?_____ Yes ☐ No ☐
10 Is the air filter installed with the proper orientation?_____ Yes ☐ No ☐

SUPPLY AIR BLOWER ASSEMBLY

ALIGNMENT_____ CHECK ROTATION_____ NAMEPLATE AMPS_____

HP	L1	L2	L3

COOLING TEST

COMPRESSORS					CRANKCASE HEATER AMPS
NUMBER	MODEL #	AMPS L1	AMPS L2	AMPS L3	
1					

AMBIENT TEMPERATURE

AMBIENT DRY BULB TEMP_____°F AMBIENT WET BULB TEMP_____°F

REFRIGERATION SYSTEM #1

	PRESSURE	SATURATED TEMPERATURE	LINE TEMPERATURE	SUB-COOLING	SUPERHEAT
DISCHARGE					
SUCTION					
LIQUID					

ELECTRIC HEATING TEST			
STAGES OF HEAT_____			
LIMIT LOCKOUT_____	AUX. LIMIT LOCKOUT_____	DOOR INTERLOCK_____	
NUMBER	AMPS	NUMBER	AMPS
1		4	
2		5	
3		6	

CONDENSER FAN AMPS				
ALIGNMENT_____☐		CHECK ROTATION_____☐		NAMEPLATE AMPS_____☐
NUMBER	HP	L1	L2	L3
1				

R-410A Saturation Pressure/Temperature Chart

(°F)	*PSIG*	*(°F)*	*PSIG*	*(°F)*	*PSIG*	*(°F)*	*PSIG*	*(°F)*	*PSIG*
20	78.3	**50**	142.2	**80**	234.9	**110**	364.1	**140**	540.1
21	80	**51**	144.8	**81**	238.6	**111**	369.1	**141**	547
22	81.8	**52**	147.4	**82**	242.3	**112**	374.2	**142**	553.9
23	83.6	**53**	150.1	**83**	246	**113**	379.4	**143**	560.9
24	85.4	**54**	152.8	**84**	249.8	**114**	384.6	**144**	567.9
25	87.2	**55**	155.5	**85**	253.7	**115**	389.9	**145**	575.1
26	89.1	**56**	158.2	**86**	257.5	**116**	395.2	**146**	582.3
27	91	**57**	161	**87**	261.4	**117**	400.5	**147**	589.6
28	92.9	**58**	163.8	**88**	265.4	**118**	405.9	**148**	596.9
29	94.9	**59**	166.7	**89**	269.4	**119**	411.4	**149**	604.4
30	96.8	**60**	169.6	**90**	273.5	**120**	416.9	**150**	611.9
31	98.8	**61**	172.5	**91**	277.6	**121**	422.5		
32	100.9	**62**	175.4	**92**	281.7	**122**	428.2		
33	102.9	**63**	178.4	**93**	285.9	**123**	433.9		
34	105	**64**	181.5	**94**	290.1	**124**	439.6		
35	107.1	**65**	184.5	**95**	294.4	**125**	445.4		
36	109.2	**66**	187.6	**96**	298.7	**126**	451.3		
37	111.4	**67**	190.7	**97**	303	**127**	457.3		
38	113.6	**68**	193.9	**98**	307.5	**128**	463.2		
39	115.8	**69**	197.1	**99**	311.9	**129**	469.3		
40	118.1	**70**	200.4	**100**	316.4	**130**	475.4		
41	120.3	**71**	203.6	**101**	321	**131**	481.6		
42	122.7	**72**	207	**102**	325.6	**132**	487.8		
43	125	**73**	210.3	**103**	330.2	**133**	494.1		
44	127.4	**74**	213.7	**104**	334.9	**134**	500.5		
45	129.8	**75**	217.1	**105**	339.6	**135**	506.9		
46	132.2	**76**	220.6	**106**	344.4	**136**	513.4		
47	134.7	**77**	224.1	**107**	349.3	**137**	520		
48	137.2	**78**	227.7	**108**	354.2	**138**	526.6		
49	139.7	**79**	231.3	**109**	359.1	**139**	533.3		

F1 SERIES AIR HANDLER

•

INSTALLATION, OPERATION
&
MAINTENANCE

AAON
2425 South Yukon
Tulsa, Oklahoma 74107
Phone: (918) 583-2266 • Fax: (918) 583-6094

R58420 · Rev. A · 080402
(ACP 29902)

F1 Series
Indoor Air Handlers
Engineering Catalog

Table of Contents

R58430 · Rev. A · 080228
(ACP 29223)

Index of Tables and Figures

Tables:

Figures:

Features and Options

AAON® F1 Series indoor air handlers, for residential and commercial applications, are return air only. The F1 Series air handler and AAON® CB Series condensing unit have been designed and engineered to work together as a high efficiency system. They can be matched to create a high efficiency cooling split system air conditioner or high efficiency heating and cooling split system heat pump.

Convenience and Serviceability
Each F1 Series air handler is delivered to the jobsite ready for connection to the condensing unit, refrigerant charging, and startup. All components are labeled and connected with color-coded wiring that matches the unit's color-coded wiring diagram. Corrosion and UV resistant condensate drain pans minimize indoor air quality concerns such as rust and water leakage and drain connections at either side of the unit allow flexibility of unit placement.

Reliability
The F1 Series air handler's cabinet is constructed entirely of embossed G90 galvanized steel to provide strength and durability. The forward curved supply blower is powered by a direct drive, variable speed, ECM motor, eliminating the necessity to adjust or replace belts.

Efficiency
ECM motor technology is not only reliable, but ultra-high efficiency, dramatically increasing the unit's SEER ratings. The electronically controlled motor quietly varies fan speed to maintain air volume, provide exceptional temperature control, and consistent comfort.

Environmentally Friendly
AAON designed and engineered the F1 air handler with the future in mind. Non-ozone depleting R-410A refrigerant, which is unaffected by refrigerant phase-out, is standard for the air handler, making it both environmentally friendly and maintainable.

Modulating Hot Gas Reheat Option - Humidity control option that minimizes temperature swings during dehumidification. Moisture related indoor air quality issues are minimized by reducing space humidity without sacrificing occupant comfort.

Split System Heat Pump Option - Energy efficient heating option that allows split system to be able to provide on demand heating and cooling with the refrigeration circuit. Option is available as a matched split system with a CB Series condensing unit and an F1 Series air handler.

Painted Cabinet Option - The F1 Series cabinet exterior can be painted to provide the unit with an attractive finish.

Application Options - The standard F1 Series air handler provides vertical upflow supply. The multi-position configuration option is designed to provide the unit with placement flexibility, allowing the unit to be able to supply air vertically (upflow), or by placing the unit on its side, to supply air horizontally.

Heating Options - An air conditioning or heat pump system can be enhanced with electric resistance heaters to provide up to 25 kW of electric heat. A hot water heating coil option is also offered on the F1 Series air handler.

www.aaon.com

The AAON F1 & CB Residential Matched Split System

The Importance of a Matched System
AAON quality components are designed to work with other brands, but replacing only one component means that you may not experience all that a matched system has to offer. Investing in AAON matched components is the best way to ensure the ultimate in home comfort, consistent performance and lower energy consumption than any other system can provide.

AAON F1 Series air handlers have been engineered to provide quiet, energy efficient, total home comfort.

Humidity Control
The AAON exclusive Modulating Hot Gas Reheat Dehumidification System represents the ultimate in comfort. The unit can dehumidify your whole home while still maintaining the desired temperature. By adding a specialized AAON control sequence and a special coil specifically designed for humidity control applications, the AAON matched system controls both temperature and humidity independently, to provide total comfort unmatched by any other system on the market.

Enhanced Air Flow
By only operating the fan at higher speeds when required by a large cooling requirement, the indoor unit operates more quietly and provides better dehumidification than other systems.

Quick and Convenient Access
Electrical, refrigeration and filter components are easily accessible through the front of the unit.

AU Series A-Coils
For added flexibility or if gas heating is required in a home a cased A-Coil can be ordered with a matching CB Series outdoor unit (furnace by others). Standard features of the A-Coil include coil housing with composite drain pan and TXV.

AAON CB Series air conditioners and heat pumps have been engineered to be durable, attractive, quiet, and energy efficient.

Economical Operation
Increased efficiency may substantially lower your home heating and cooling costs.

Two-Stage Cooling
Two stages of cooling meet any outdoor climate conditions, supply consistent interior comfort and provide improved humidity control.

Durable Construction
Components are selected to provide long-lasting performance and reliability.

Environmentally Friendly
AAON residential products never contain the refrigerant known as R-22. AAON uses refrigerant R-410A, which contains no chlorine, so it is not damaging to the atmosphere's ozone layer.

Figure B1 - CB Series Condensing Unit

F1 Base Model and Features Description

Model/Feature Number

F	1	-	A	-	0	6	0	-	1	-	M	-	C	-	C	0	0	0	C	0	0	0	0	0
1	2		3		4	5	6		7		8		9		10	11	12	13	14	15	16	17	18	19

BASE MODEL

Digit 1, 2: GENERATION
F1

Digit 3: REVISION
A = Design Sequence

Digit 4,5,6: UNIT SIZE
024 = 24 MBH (2 Ton)
036 = 36 MBH (3 Ton)
048 = 48 MBH (4 Ton)
060 = 60 MBH (5 Ton)

Digit 7: VOLTAGE
1 = 208-230V/1Φ/60Hz
C = 115V/1Φ/60Hz

Digit 8: APPLICATION
V = Vertical Position (Upflow)
M = Multi-Position (Upflow or Horizontal)

Digit 9: HEATING
0 = No Heat
A = 5 kW
B = 10 kW
C = 15 kW
D = 20 kW
E = 25 kW
G = Hot Water Heating

FEATURE 1: MOTORS

Digit 10:
A = ECM - 1/2 hp
B = ECM - 3/4 hp
C = ECM - 1.0 hp

FEATURE 2: FILTERS

Digit 11:
0 = Standard - 1” Fiberglass

FEATURE 3: CONTROLS

Digit 12:
0 = Standard - Terminal Block

FEATURE 4: BLANK

Digit 13:
0 = Standard

FEATURE 5: REFRIGERATION

Digit 14:
0 = Standard - Split System Air Conditioner
C = Split System Heat Pump
D = Split System Air Conditioner + Modulating Hot Gas Reheat
F = Split System Heat Pump + Modulating Hot Gas Reheat

FEATURE 6: BLANK

Digit 15:
0 = Standard

FEATURE 7: BLANK

Digit 16:
0 = Standard

FEATURE 8: BLANK

Digit 17:
0 = Standard

FEATURE 9: CABINET

Digit 18:
0 = Standard - Embossed Galvanized Steel
A = Painted Cabinet Exterior

FEATURE 10: SPECIAL

Digit 19:
0 = Standard
X = Special Price Authorization

Model Number
Revision

Example: F1-**A**-060-1-M-C:C000C00000

A = *Design Sequence* - This digit is used for future product updates, improvements, and revisions.

Model Number
Unit Size

Example: F1-A-**060**-1-M-C:C000C00000

The unit size designates nominal MBH cooling capacity when matched with a comparable condensing unit at standard conditions (95°F Ambient, 45°F Saturated Suction). Actual capacities will vary with conditions.

Table M1 - Unit Sizes

Model	Nominal Values						
	MBH	Tons	CFM	Width	Height	Length	Weight
F1-**024**	24	2	800	21”	51”	21”	159 lbs.
F1-**036**	36	3	1200				
F1-**048**	48	4	1600	25”	59”	22”	215 lbs.
F1-**060**	60	5	2000				

Model Number
Voltage

Example: F1-A-060-**1**-M-C:C000C00000

All units have single point power blocks with grounding lugs, 24 VAC control circuits, and branch circuit fusing.

1 = 208-230V/1Φ/60Hz
C = 115V/1Φ/60Hz

Model Number
Application

Example: F1-A-060-1-**M**-C:C000C00000

V = *Vertical (Upflow)* - Vertical air handler cabinet with top supply air connection, with duct flange.
M = *Multi-Position (Upflow or Horizontal)* - Multi-position cabinet option that allows the unit to be installed with top supply air connection, with duct flange or horizontal supply air connection, with duct flange. Factory installed condensate drain pans and connections provide for either configuration.

Model Number
Heating

Example: F1-A-060-1-M-**C**:C000C00000

0 = *No Heat*
***A** = 5 kW *Electric Heat* - Single element heater with 5kW element for 230V (3.75kW for 208V). The 5 kW option is single stage heating.
***B** = *10 kW Electric Heat* - Multiple element heater with one 10kW element for 230V (7.5kW for 208V). The 10kW option is single stage heating.
***C** = *15 kW Electric Heat* - Multiple element heater with one 10kW and one 5kW element for 230V (7.5kW and 3.75kW for 208V). The 15 kW option is two stage heating.
***D** = *20 kW Electric Heat* - Multiple element heater with two 10kW elements for 230V (7.5kW for 208V). The 20 kW option is two stage heating.
***E** = *25 kW Electric Heat* - Multiple element heater with two 10kW elements and one 5kW element for 230V (7.5kW and 3.75kW for 208V). The 25 kW option is three stage heating, with W1 and W2 terminals and a time delayed third stage.
G = *Hot Water Heating Coil* - Aluminum finned copper tube hot water heating coil. Valves must be field provided. Not available on units with modulating hot gas reheat (Feature 5 = D or F).

*Field power wiring to each electric heat circuit breaker is required. Not available on 115V/1Φ/60Hz units.
Note: For commercial applications, AAONEcat32™ will calculate the heating size for electric heat and choose the correct heating option, if any of the electric heat options are selected, based on the desired leaving air and entering air temperature conditions.

Feature 1
Motors

Example: F1-A-060-1-M-C:**B**000C00000

A = *ECM - 1/2 hp* - The supply blower is powered by an ultra-high efficiency, direct drive, electronically commutated motor (ECM) that provides quiet operation, low power consumption, and increased SEER when compared to induction motors. The motor is inherently variable, adjusting fan speed to maintain airflow. Standard size motor for F1-024 and F1-036.
B = *ECM - 3/4 hp* - Same as option A except standard size motor for F1-048 and F1-060. Optional high static pressure motor for F1-024 and F1-036.
C = *ECM - 1.0 hp* - Same as option A except optional high static pressure motor for F1-048 and F1-060.

Note: For commercial applications, AAONECat32™ will select the correct option for Feature 1 based on unit conditions and the input from the fan selection program. When all of the other features have been selected, you will be prompted to select the supply blower motor under the "Fan Selection" window. Fan curves will also be available for viewing.

Feature 2
Filters

Example: F1-A-060-1-M-C:C**0**00C00000

0 = *Standard - 1" Fiberglass* - Unit filter frame with replaceable 1" thick fiberglass air filter.

Feature 3
Controls

Example: F1-A-060-1-M-C:C0**0**0C00000

0 = *Standard - Terminal Block* - Terminal block for power and thermostat/humidistat controls wiring. Electrical safeties include internal fan motor overload protection and branch circuit fusing.

Feature 4
Blank

Example: F1-A-060-1-M-C:C00**0**C00000

0 = *Standard*

Feature 5
Refrigeration

Example: F1-A-060-1-M-C:C000**C**00000

0 = *Split System Air Conditioner* - Split system air conditioner for energy efficient cooling. Liquid line filter dryer is factory provided and field installed with the CB Series condensing unit.
***C** = *Split System Heat Pump* - Factory installed reversing valve in the matching CB Series condensing unit along with heat pump TXV valves, on both the F1 and CB coils, allows the indoor coil to act as the condenser and the outdoor coil to act as the evaporator for energy efficient heating, in addition to energy efficient cooling. CB Series condensing unit also includes factory installed suction line accumulator and factory provided and field installed heat pump liquid line filter dryer and liquid line receiver tank.
***D** = *Split System Air Conditioner + Modulating Hot Gas Reheat* - Factory installed reheat coil mounted downstream of the evaporator coil with modulating control valves in the matching CB Series condensing unit which together provide humidity control. Digital controller and modulating valves control the flow of refrigerant to the reheat coil to maintain precise supply air temperature during dehumidification. A thermostat with a built in humidistat (Normally Closed) or stand alone wall mounted space humidistat (NC) is required and available as an accessory. Liquid line filter dryer, liquid line receiver tank, reheat coil check valve, and liquid line check valve are factory provided and field installed. Requires field installation of a hot gas line from CB Series condensing unit to reheat coil (See F1 or CB IOM for installation details). Field installed suction line accumulator is recommended.
***F** = *Split System Heat Pump + Modulating Hot Gas Reheat* - Options C + D. A thermostat with a built in humidistat (Normally Closed) or stand alone wall mounted space humidistat (NC) is required and available as an accessory. Heat pump liquid line filter dryer, liquid line receiver tank, and reheat coil check valve are factory provided and field installed. Requires field installation of a hot gas line from CB Series condensing unit to reheat coil (See F1 or CB IOM for installation details). CB Series condensing unit includes factory installed suction line accumulator.

*These options are available with the selection of a matching CB Series condensing unit.

Feature 6
Blank

Example: F1-A-060-1-M-C:C000C**0**0000

0 = *Standard*

Feature 7
Blank

Example: F1-A-060-1-M-C:C000C0**0**000

0 = *Standard*

Feature 8
Blank

Example: F1-A-060-1-M-C:C000C00**0**00

0 = *Standard*

Feature 9
Cabinet

Example: F1-A-060-1-M-C:C000C000**0**0

0 = *Standard - Embossed Galvanized Steel* - Single wall embossed G90 galvanized steel cabinet construction with 1/2", 1.5 lb./ft^3 foil faced insulation. Corrosion and UV resistant drain pan(s).
A = *Painted Cabinet Exterior* - Same as option 0, except cabinet exterior is painted gray. Option is intended to provide an attractive exterior for visible units. Paint finish exceeds 1000 hour salt spray test when tested under ASTM B 117-95 requirements.

Feature 10
Type

Example: F1-A-060-1-M-C:C000C0000**0**

0 = *Standard*
X = *Special Price Authorization* - The Applications Department must issue a Special Pricing Authorization (SPA) to include a non-standard option.

General Data

Unit Information

Table G1 - F1 Unit Data

	F1-024	F1-036	F1-048	F1-060
Supply Blower				
Type/Diameter	FC (Forward Curved)/9”		FC/10”	
Standard Motor	1/2 hp		3/4 hp	
High Static Application Motor	3/4 hp		1 hp	
Nominal CFM	800	1200	1600	2000
Evaporator A-Coil				
Refrigerant	R-410A			
Coil Face Area	4 ft^2		5.4 ft^2	
Rows/FPI	3/14		3/12	
Electric Heat				
kW Capacity - 230 V	5, 10	5, 10, 15	5, 10, 15, 20	5, 10, 15, 20, 25
kW Capacity - 208V	3.75, 7.5	3.75, 7.5, 11.25	3.75, 7.5, 11.25, 15	3.75, 7.5, 11.25, 15, 18.75
Stages	5, 10 kW - 1 stage / 15, 20 - 2 stage / 25 kW - 3 stage			
Hot Water Coil				
Coil Face Area	1.56 ft^2		1.88 ft^2	
Rows/FPI	4/10			
Condensate Drain	3/4” Connection			
Air Filter	20” x 20” x 1”			

Table G2 - Matching CB Unit Data

	CB-024	CB-036	CB-048	CB-060
Compressor				
Type	R-410A Two Step Scroll			
Number/Nominal Tons	1/2	1/3	1/4	1/5
Crankcase Heater	Yes			
Condenser Fan				
Number/Diameter	1/22”		1/26”	
hp	1/3			
Condenser Coil				
Rows	1			
Liquid Line Connection	3/8”			
Suction Line Connection	3/4”		7/8”	
Nominal Unit Weight (lbs.)	257		306	

Electrical Information

Table E1 - F1 Supply Fan and Unit Electrical Data

Unit Voltage	Supply Fan		Unit		
	hp	FLA	FLA	MCA	MOP
208-230V/1Φ	0.5	4.2	4.2	5.0	15.0
	0.75	5.4	5.4	7.0	15.0
	1.0	8.0	8.0	10.0	15.0
115V/1Φ	0.5	7.7	7.7	9.6	15.0
	0.75	9.6	9.6	12.0	15.0
	1.0	12.8	12.8	16.0	20.0

Table E2 - F1 Electric Heat Electrical Data

Unit Voltage	kW	Circuit #	Amps	MCA	MOP
208-230V/1Φ	5	1	21	26.0	30
	10	1	42	52.1	60
	15	1	42	52.1	60
		2	21	26.0	30
	20	1	42	52.1	60
		2	42	52.1	60
	25	1	42	52.1	60
		2	42	52.1	60
		3	21	26.0	30

Note: Electric heat is not available on 115V/1Φ F1 Series air handler

Table E3 - Matching CB Electrical Data

Model	Voltage	Unit			Compressor	Condenser Fan
		FLA	MCA	MOP	Quantity / RLA	Quantity / hp / FLA
CB-024	208-230/1Φ	14.2	17.1	25.0	1 / 11.4	1 / 0.33 / 2.8
CB-036		21.4	26.0	40.0	1 / 18.6	
CB-048		26.4	32.3	50.0	1 / 23.6	
CB-060		31.4	38.5	60.0	1 / 28.6	

AAON
www.aaon.com

9” Supply Blower Fan Curves

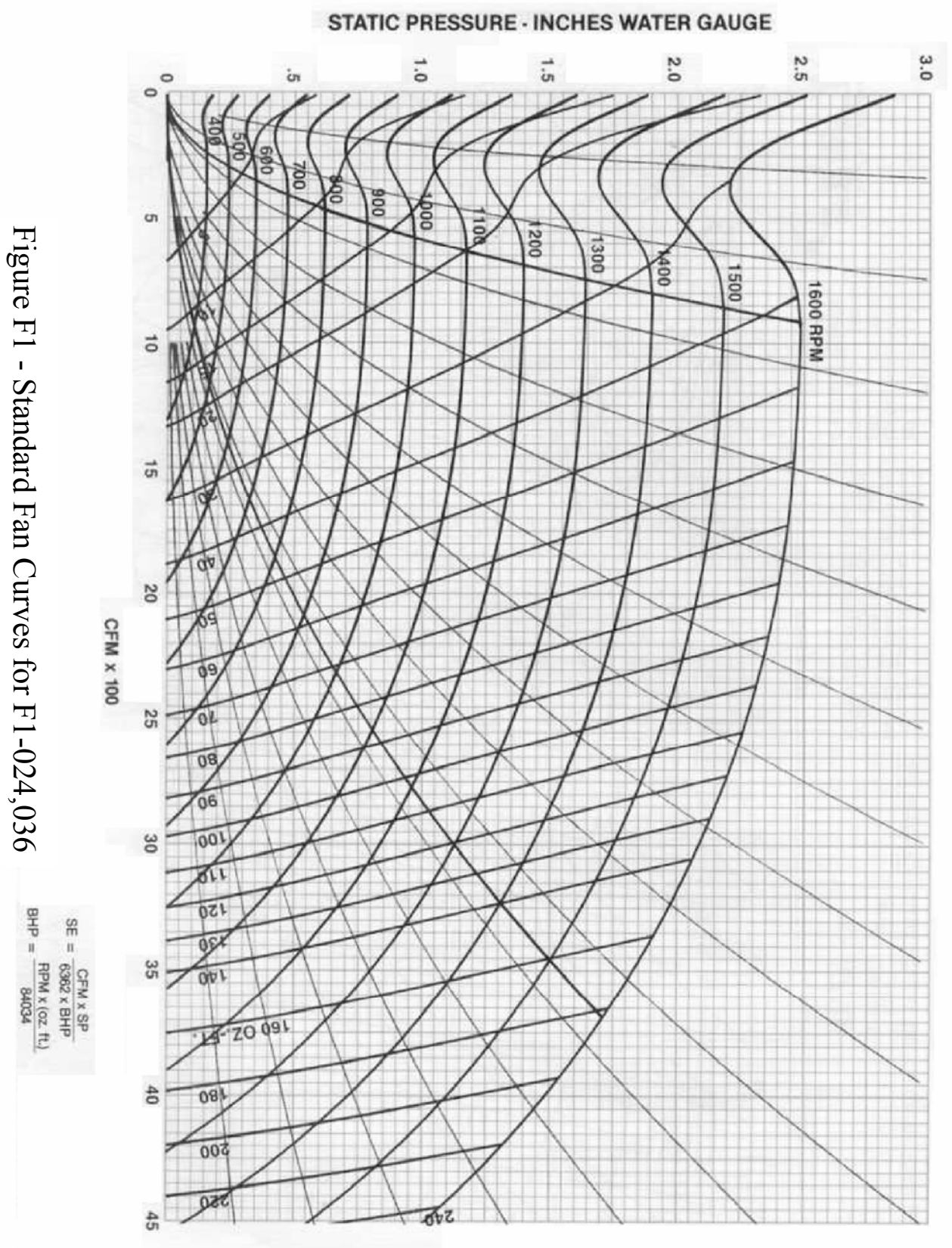


Figure F1 - Standard Fan Curves for F1-024,036

10” Supply Blower Fan Curves

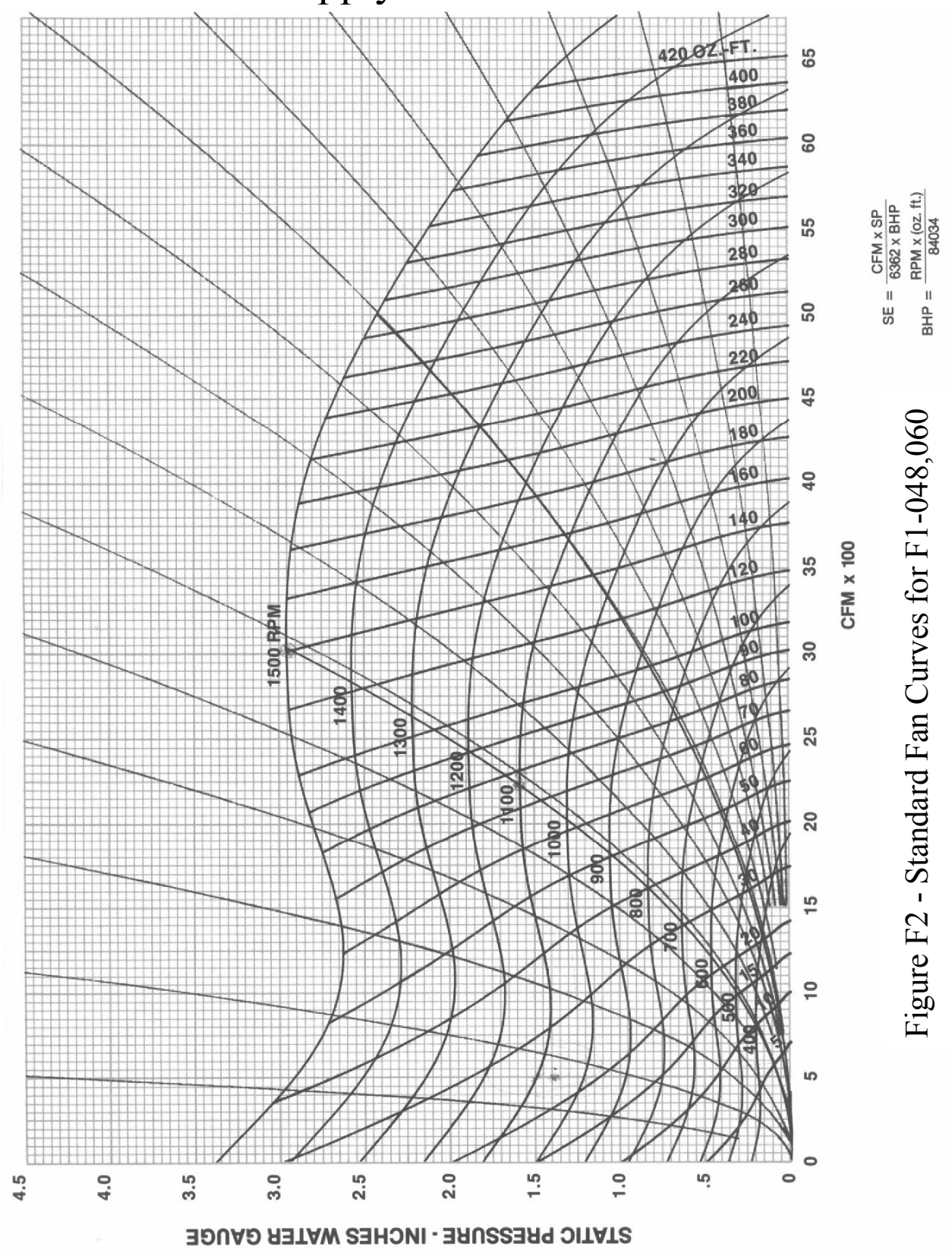


Figure F2 - Standard Fan Curves for F1-048,060

Performance Data

Table P1 - Matching CB and F1 Air Conditioner Performance Data

Condensing Unit	Air Handler	Nominal Capacity	SEER
CB-024	F1-024	24 MBH / 2 Tons	17.2
CB-036	F1-036	36 MBH / 3 Tons	15.5
CB-048	F1-048	48 MBH / 4 Tons	15.6
CB-060	F1-060	60 MBH / 5 Tons	14.6

Table P2 - Matching CB and F1 Heat Pump Performance Data

Condensing Unit	Air Handler	Nominal Capacity	SEER	HSPF
CB-024	F1-024	24 MBH / 2 Tons	16.30	8.45
CB-036	F1-036	36 MBH / 3 Tons	14.80	8.50
CB-048	F1-048	48 MBH / 4 Tons	14.65	8.65
CB-060	F1-060	60 MBH / 5 Tons	14.40	8.30

Table P3 - Matching CB and AU, Air Conditioner Performance Data

Condensing Unit	A-Coil	Nominal Capacity	SEER
CB-024	AU-024	24 MBH / 2 Tons	14.95
CB-036	AU-036	36 MBH / 3 Tons	14.78
CB-048	AU-048	48 MBH / 4 Tons	14.46
CB-060	AU-060	60 MBH / 5 Tons	13.53

Table P4 - Matching CB and AU, Heat Pump Performance Data

Condensing Unit	Air Handler	Nominal Capacity	SEER	HSPF
CB-024	F1-024	24 MBH / 2 Tons	14.17	8.91
CB-036	F1-036	36 MBH / 3 Tons	14.33	9.05
CB-048	F1-048	48 MBH / 4 Tons	14.12	9.38
CB-060	F1-060	60 MBH / 5 Tons	13.10	8.66

Unit Drawings

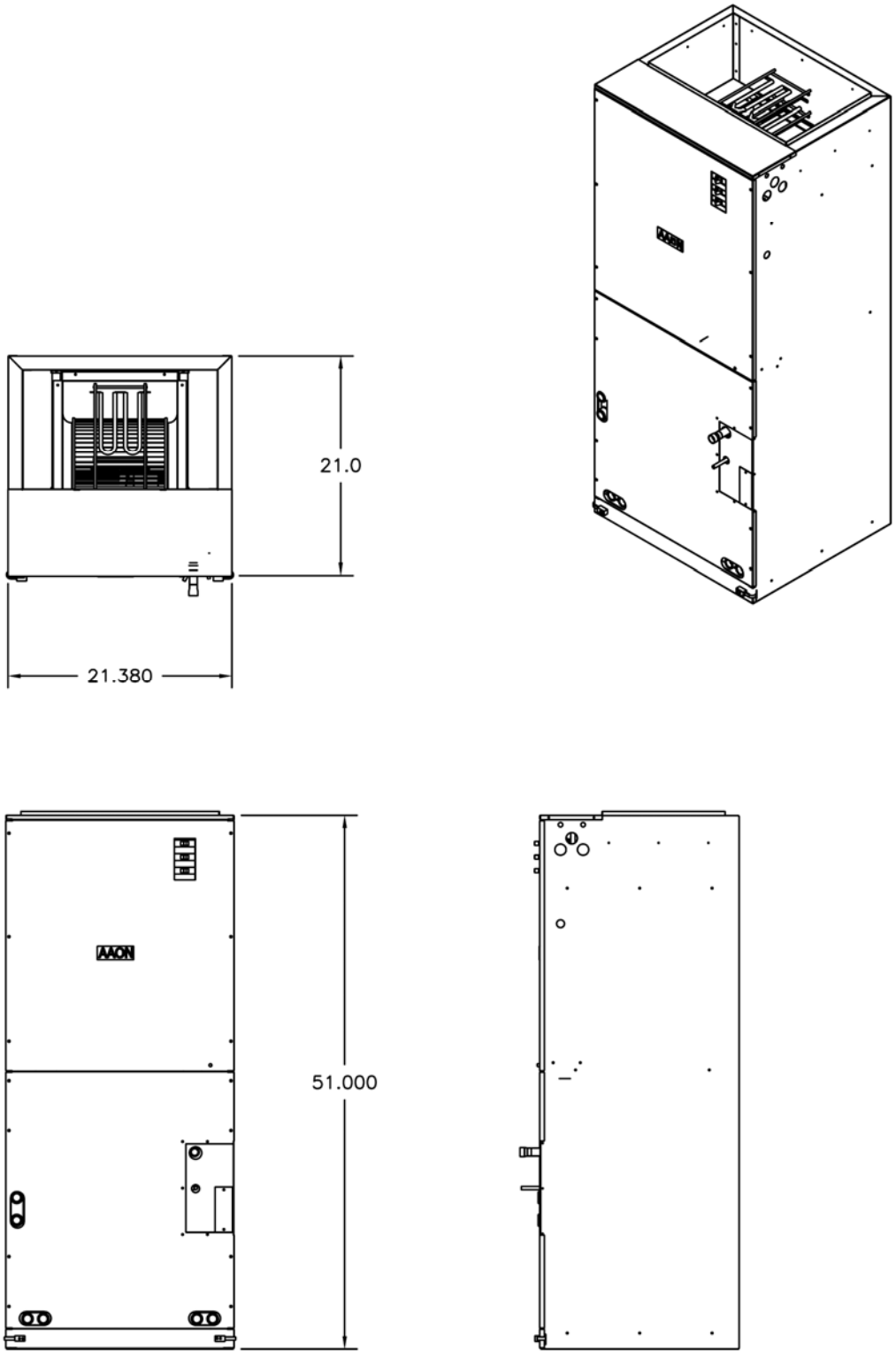


Figure U1 - Standard F1-024 and F1-036 Air Handlers

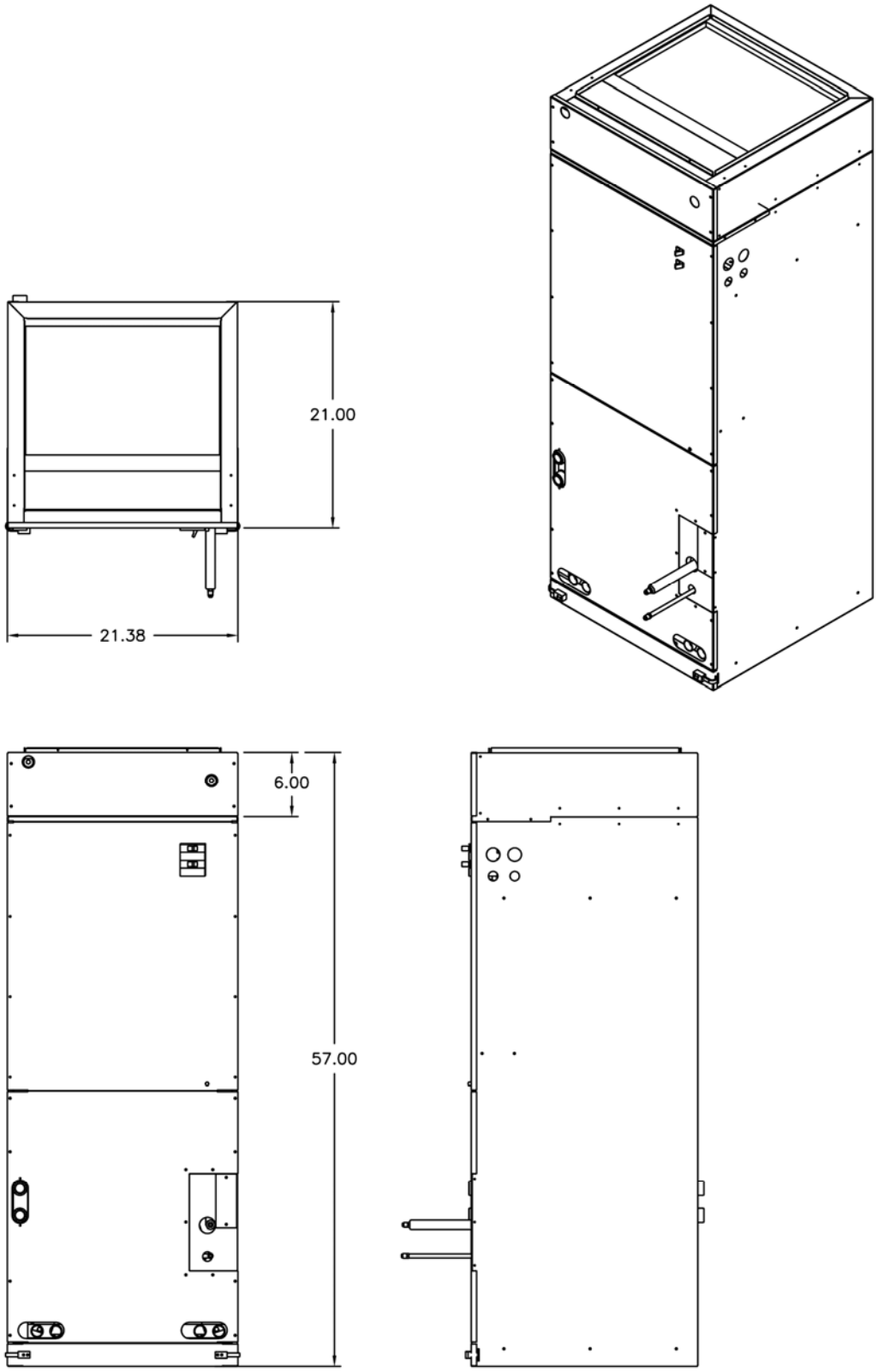


Figure U2 - Modulating Hot Gas Reheat F1-024 and F1-036 Air Handlers

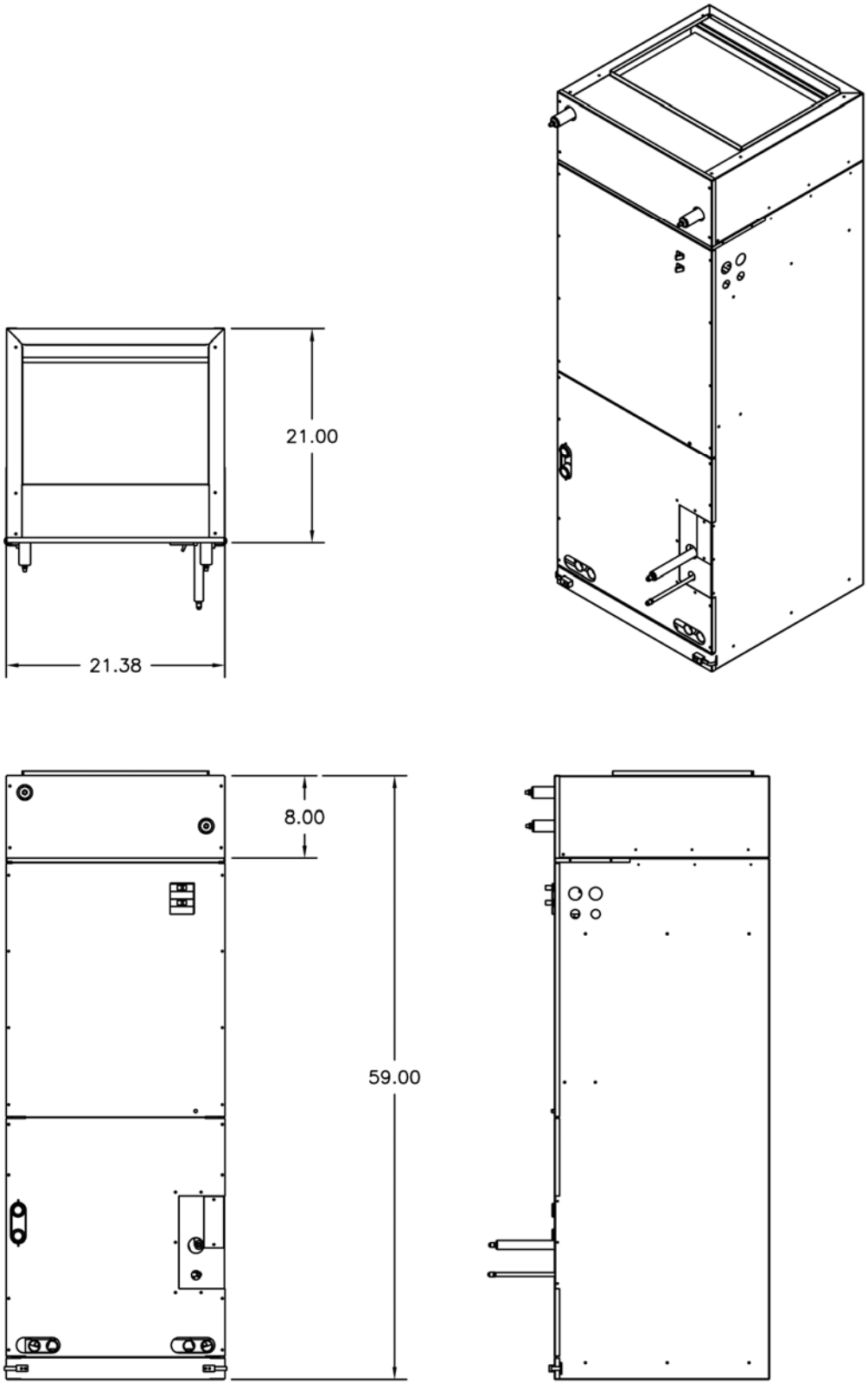


Figure U3 - Hot Water Heating F1-024 and F1-036 Air Handlers

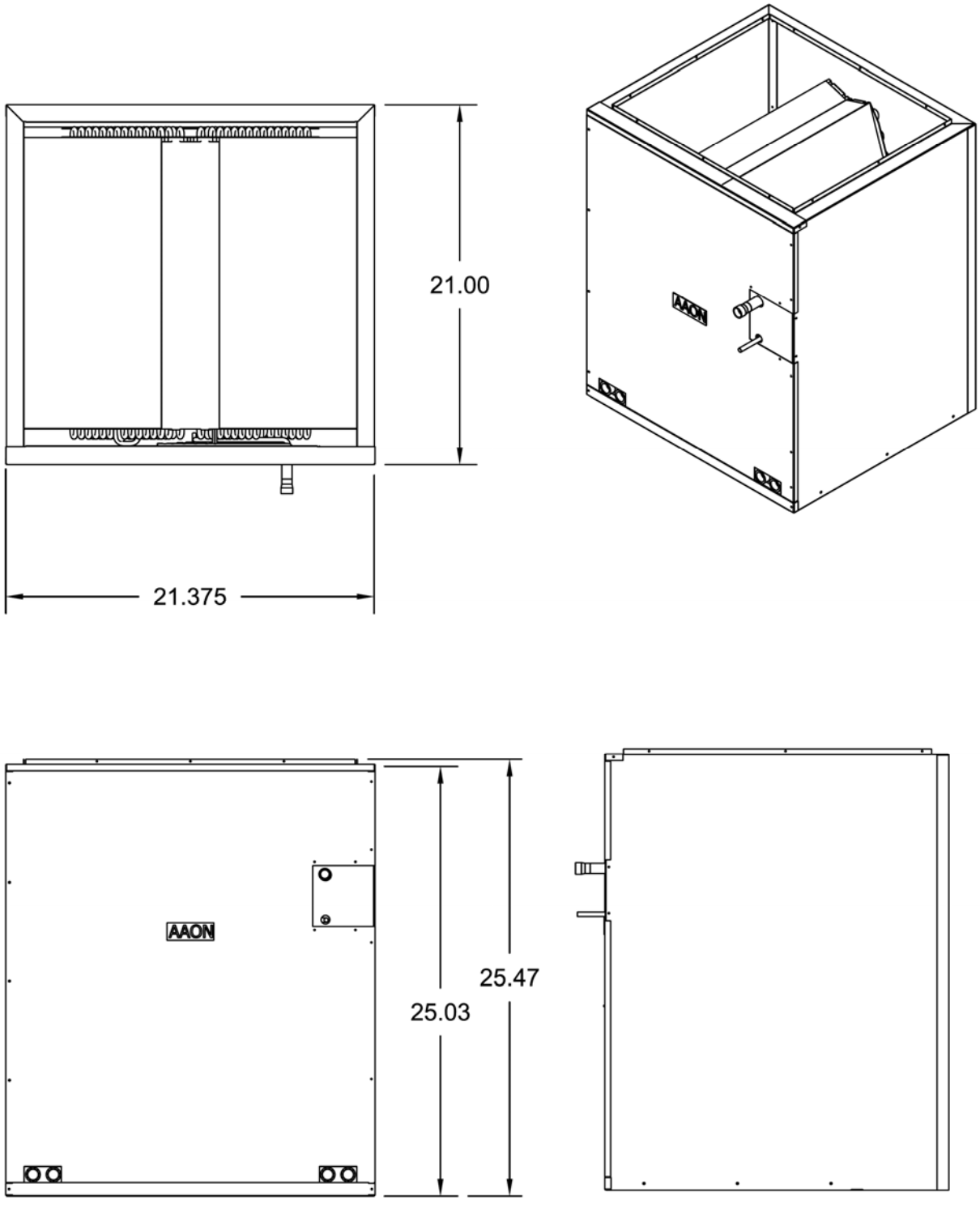


Figure U4 - AU-024 and AU-036 A-Coils

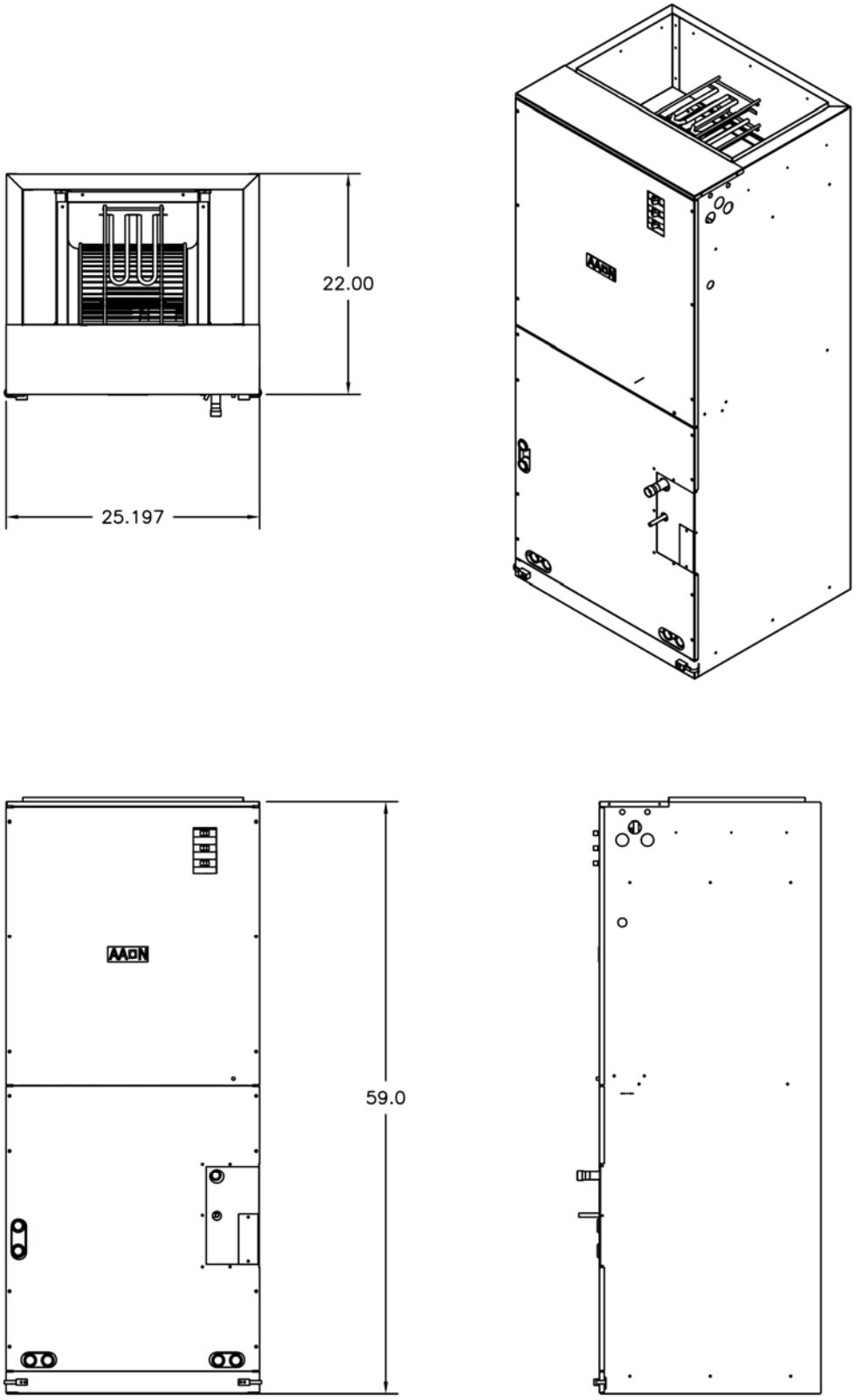


Figure U5 - Standard F1-048 and F1-060 Air Handlers

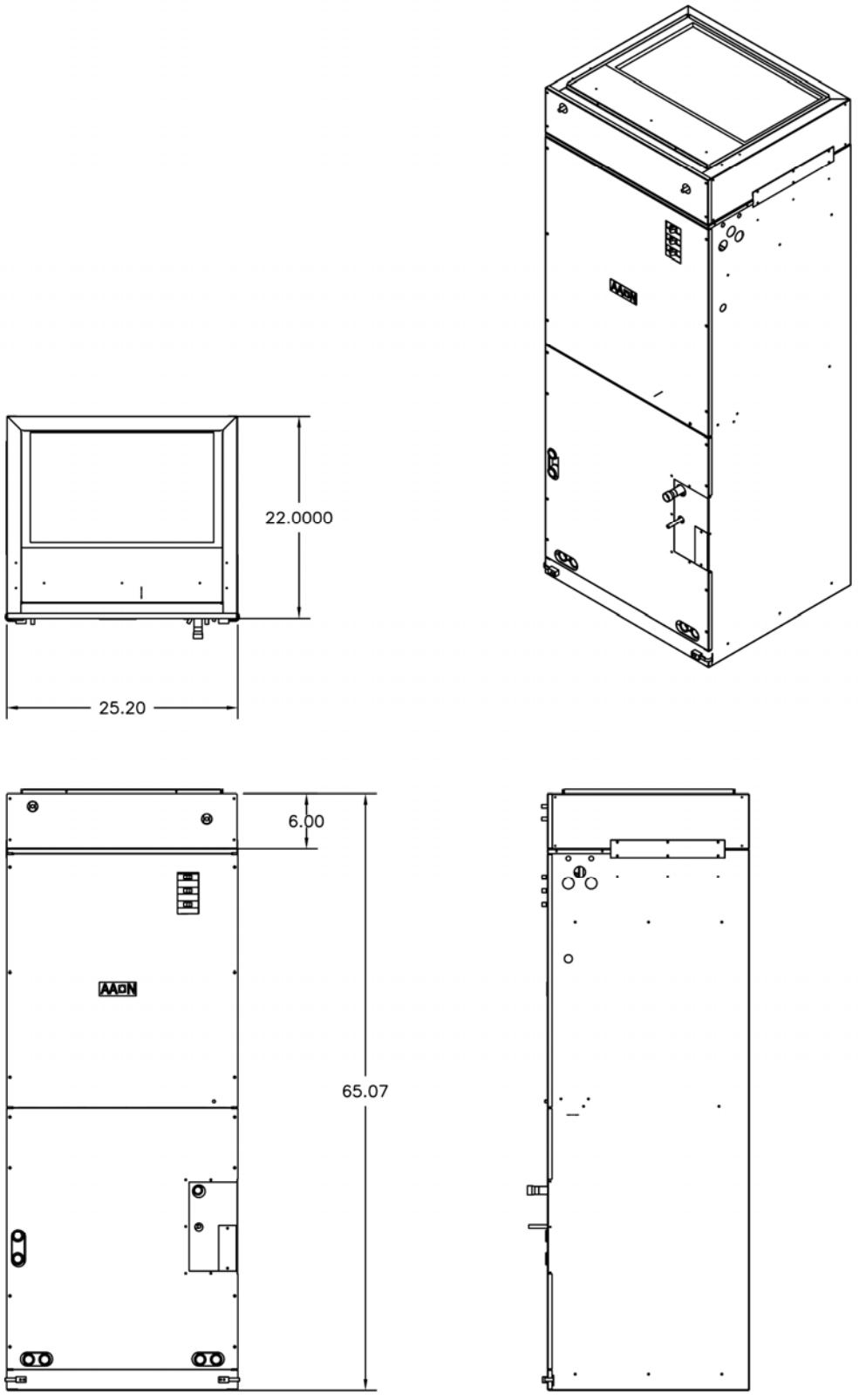


Figure U6 - Modulating Hot Gas Reheat F1-048 and F1-060 Air Handlers

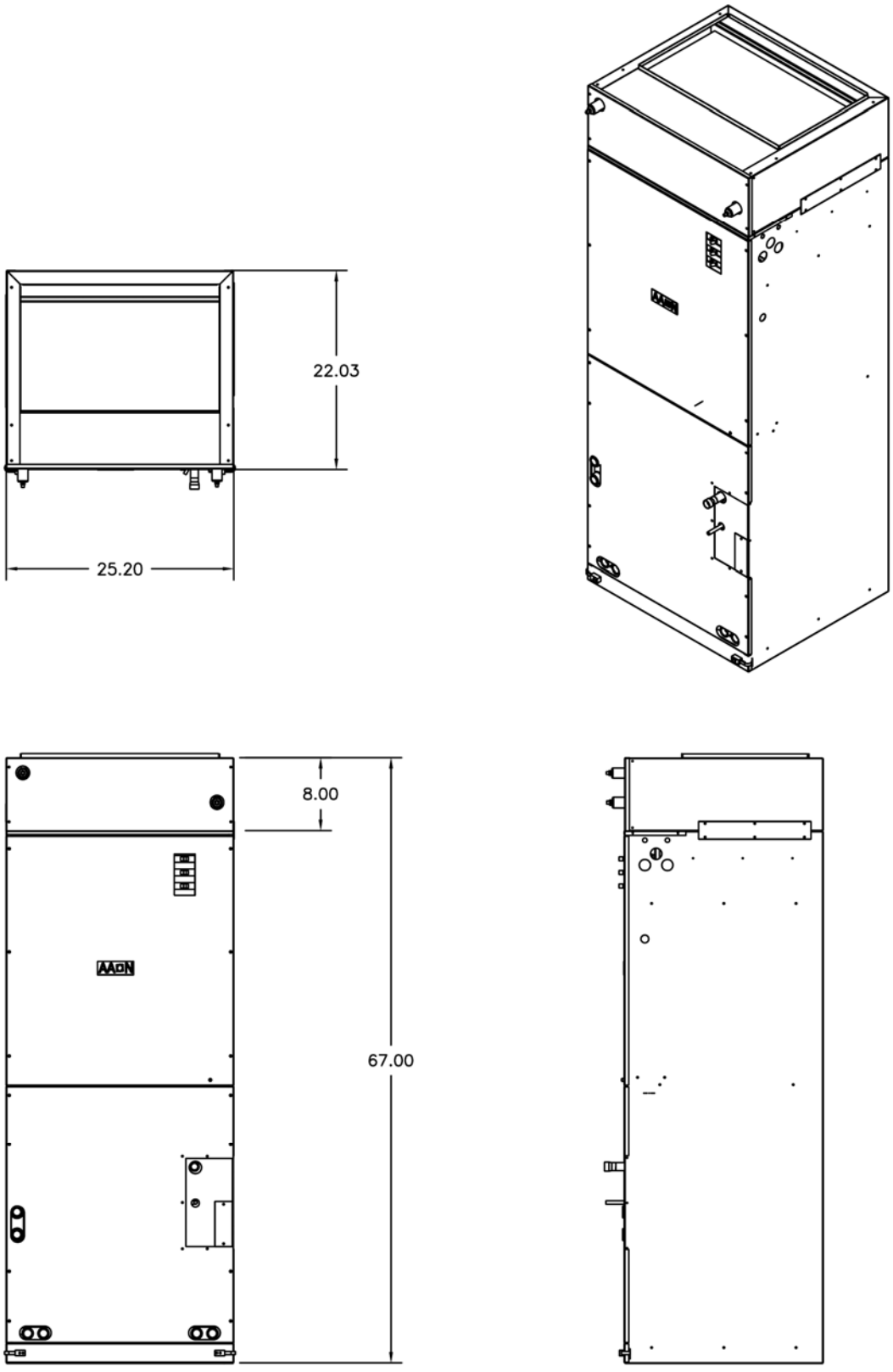


Figure U7 - Hot Water Heating F1-048 and F1-060 Air Handlers

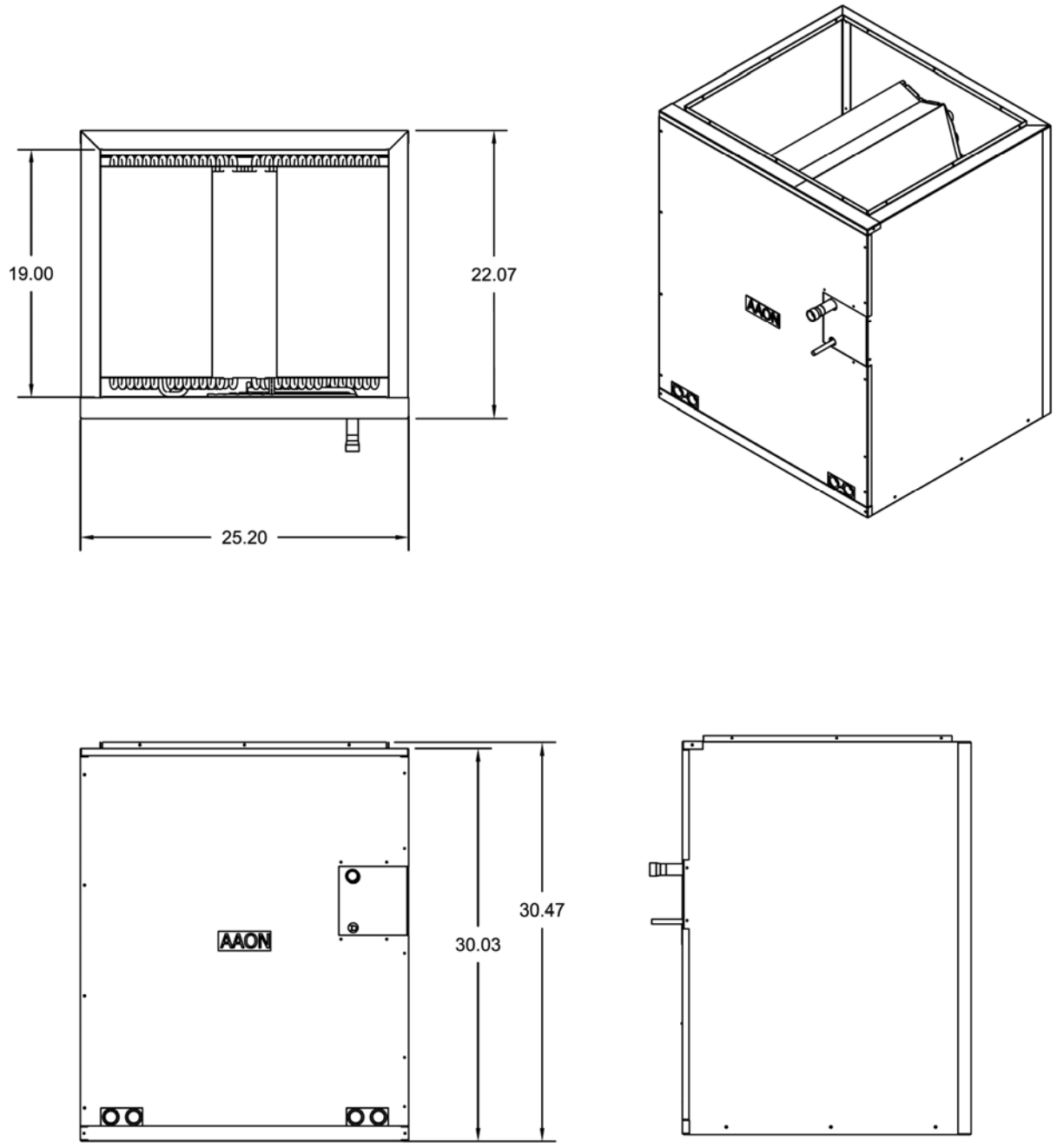


Figure U8 - AU-048 and AU-060 A-Coils

Guide Specifications - AAON F1 Series Indoor Air Handlers

SECTION 15855 – AIR HANDLING UNITS WITH COILS

PART 1: GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this section.

1.02 SUMMARY

A. This Section includes design, refrigerants, controls, and installation requirements for indoor air handling units.

1.03 SUBMITTALS

A. Product Data: Provide literature that indicates dimensions, weights, capacities, ratings, fan performance, data of filter media, and electrical characteristics and connection requirements.

B. Shop Drawings: Indicate assembly, unit dimensions, construction details, field connection details, and connection requirements. Computer generated fan curves for each air handling unit shall be submitted with specific design operating point noted.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

C. Commissioning Reports: Indicate results of startup and testing commissioning requirements. Submit copies of checklists.

D. Maintenance Data: Maintenance manuals specified in Division 1.

E. Warranties: Special warranties specified in this Section.

1.05 SAFETY AGENCY LISTED AND CERTIFICATION

A. Fan performance ratings shall conform to AMCA 210 procedures.

1.06 DELIVERY AND HANDLING

A. Unit shall be wrapped by the manufacturer prior to shipment to prevent damage due to weather and road debris during transportation and thereafter while in storage awaiting installation.

B. Protection of the complete unit for avoidance of general rusting must be handled as best suits the circumstances.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.

1.07 WARRANTY

A. The refrigeration equipment manufacturer's warranty shall be for a period of one year from date of equipment start up but not more than 18 months from date of shipment. The warranty shall cover material and workmanship that prove defective within the above period, excluding refrigerant.

Option:

1. With a residential CB and F1 or CB and AU matched split system, manufacturer's warranty shall be for a period of 5 (10) years. Warranty shall begin on the date of the original installation, or three months after date of original shipment from the factory (as shown on the warranty certificate), whichever occurs first. The warranty shall cover material and workmanship that prove defective within the above period, under normal use and maintenance. Refer to the Limited Warranty Certificate.

1.08 MAINTENANCE

A. Maintenance of the unit shall be responsibility of the owner and performed in accordance with the manufacturer's instructions.

PART 2: PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to strict compliance with the requirements of this specification, provide products by one of the following:

1. Indoor Air Handlers:

a. AAON

2.02 AIR HANDLERS

A. Unit Description:

1. Fabricate air handling units suitable for the scheduled capacities.

2. Units shall be ETL listed in compliance with UL/ANSI Standard 1995

3. Factory test and balance fan design to limit vibration at operating speeds.

4. All internal components specified in the air handling unit schedule shall be factory furnished and installed.

Option:

a. Indoor air handler and matching outdoor condensing unit shall be capable of operation as a split system heat pump.

B. Construction:

1. Unit structural members shall be manufactured of G90 galvanized sheet metal.

2. Units shall be specifically designed for indoor application. The interior air side of the cabinet shall be entirely insulated on all exterior panels with 1/2" thick, 1 1/2 lb. density fiberglass insulation

3. Access to the blower, coils, and other items needing periodic checking or maintenance shall be through removable access panel.

4. Air side service access panels shall be fully gasketed.

5. Vertical position models shall have a top vertical discharge air pattern when viewed from the front side of the unit.

6. Multi-position models shall incorporate a multi-position condensate drain pan allowing the unit to be made vertical with top discharge air pattern or horizontal with a straight through discharge air pattern when viewed from the front side of the unit.

7. Air handlers shall have a sloped condensate drain pan of composite construction, with a connection provided on each side of the unit. The multi-position unit condensate drain pan shall be adjustable so that horizontal air flow is from right to left or from left to right when viewed from the access panel side of the unit.

Option:

a. Cabinet exterior shall be painted. Paint finish shall be capable of withstanding at least 1000 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.

2.03 AIR HANDLER FEATURES

A. Supply Blower:

1. Supply blower shall be direct drive forward curved, driven by an ECM, electronically commutated motor.

B. Electrical:

1. Unit shall have a single point power connection terminal block for field connection to the electrical power source. Electric heat circuits shall require additional power wiring.

2. Each unit shall include a 24 volt control circuit transformer and a fan contactor for operation of the blower motor.

C. Evaporator Coil:

1. Coil shall be fabricated of seamless copper tubes with aluminum fins mechanically bonded to the tubes. Headers on the coils shall be extra heavy wall seamless drawn copper tubing with die formed end closures for added strength.

2. Evaporator shall be designed for use with R-410A refrigerant and be furnished with an externally equalized, thermostatic expansion valve, factory supplied, mounted and piped.

3. Field connections shall be made to the suction and liquid line connections furnished by the manufacturer at the side of the unit. The sensing bulb for the expansion valve shall be field installed on the suction line immediately outside the air handler cabinet.

C. Refrigeration Circuit:

1. Circuit shall operate on R-410A refrigerant. Liquid line filter dryer shall be supplied with matching condenser.

2. The finished field installed refrigerant circuit furnished by the contractor shall include the low side cooling components, refrigerant, thermal expansion valve, liquid line, (insulated hot gas line), and insulated suction line.

Options:

a. Unit shall dehumidify using a hot gas reheat coil, modulating hot gas reheat control valves piped to the refrigerant system, and an electronic controller. A factory-wired, field installed, supply air temperature sensor and a field-installed humidistat or thermostat with humidistat shall control the dehumidification. The supply air temperature setpoint shall be adjustable on the electronic controller within the controls compartment.

C. Hot Water Coil:

1. Coil shall be fabricated of seamless copper tubes with aluminum fins mechanically bonded to the tubes. Headers on the coils shall be extra heavy wall seamless drawn copper tubing with die formed end closures for added strength.

2. Coil fins shall be constructed of aluminum and have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.

3. Coil casings shall be a formed channel frame of galvanized steel.

D. Electric Heat:

1. Manufacturer shall supply the electric resistance heating assembly with the capacity and number of steps as listed in the schedule. All heating elements shall be open wire type with nichrome wire mounted in ceramic insulators. The heater elements(s) shall be controlled by a 24 volt normally open contactor(s). The assembly shall be furnished with proper internal components and shall bear the ETL listing label.

E. Filters:

1. The unit shall be furnished with 1" fiberglass panel filters. Filter shall be removable from the side of the cabinet.

F. Wiring Diagrams:

1. Wiring diagrams shall be in color and marked to match the color and markings of the wires.

2. Installation, Operation, and Maintenance manual shall be supplied with each unit within the control compartment.

PART 3: EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's Installation, Operation, and Maintenance instructions.

3.02 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

B. Manufacturer's start-up requirements must be complied with to ensure safe and correct operation

AAON
2425 South Yukon Ave.
Tulsa, OK 74107-2728
Phone: 918-583-2266
Fax: 918-583-6094
www.aaon.com

F1 Series Engineering Catalog
R58430 · Rev. A · 080228
(ACP 29223)

AAON

F1 Series

VERTICAL & MULTI-POSITION INDOOR AIR HANDLERS

Features:

- 800-2000 CFM
- Vertical Model for Upflow Applications and Multi-position Model for Either Upflow or Horizontal Applications
- R-410A DX Cooling
- Electric, Hot Water, or Heat Pump Heating
- Modulating Humidity Control
- Ultra-High Efficiency ECM Supply Blower Motor
- Labeled Components for Quick and Easy Installation
- Labeled Controls Components with Color-Coded Wiring that Matches the Unit Wiring Diagram Included in the Controls Compartment
- Matching CB Series Condensing Units Available for a Complete Split System Solution
- ETL and ARI Listed

Application Flexibility
Minimizes Installation Time and Reduces Cost

- *High Efficiency Heat Pump Option*
- *Modulating Dehumidification*
- *Part Load Capability*
- *Quiet Operation*

F1 Series Indoor Air Handlers

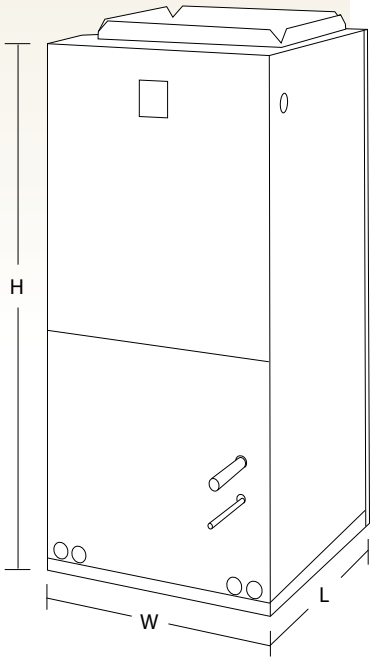
AAON® F1 Series indoor air handlers can be used for residential and light commercial applications. The F1 Series air handler and AAON® CB Series condensing unit have been designed and engineered to work together as a high efficiency system. They can be matched to create a high efficiency cooling split system air conditioner or high efficiency heating and cooling split system heat pump.

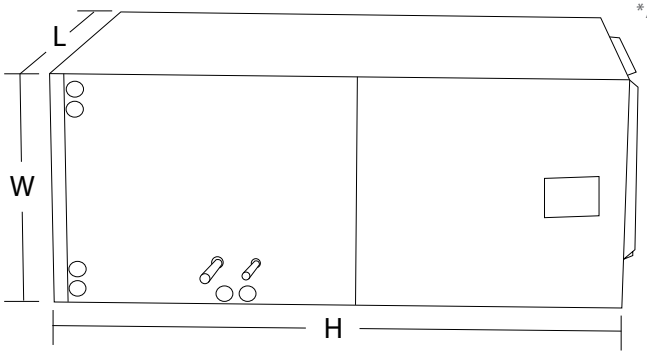
Superior Features

- Direct drive forward curved supply blower with ECM motor provides quiet and energy efficient airflow.
- Galvanized steel construction with foil faced insulation and a removable double wall service compartment panel allow the unit to be easily cleaned and maintained.
- Sloped composite drain pan, with drain connections available on either side of the unit, resists corrosion and makes the unit easy to install.
- Factory installed TXV reduces start up time and performs more efficiently than a fixed orifice design.
- Non-ozone depleting R-410A refrigerant, which is unaffected by the refrigerant phase-out, is both environmentally friendly and maintainable.
- Filter rack with quickly replaceable 1" fiberglass air filter.

Premier Options

- Electric, hot water, or heat pump heat options provide heating design flexibility.
- Modulating hot gas reheat for energy efficient and comfortable dehumidification.
- Vertical (Upflow) and Multi-Position (Upflow or Horizontal) options for application flexibility.
- Painted external cabinet finish to provide the unit with corrosion resistance and longer life.
- Standard 5 and optional 10 year residential parts warranties, when matched with a CB Series condensing unit.





F1 Model	Nominal CFM	Width	Height*	Length
024	800	21	51	21
036	1,200			
048	1,600	25	59	22
060	2,000			

All dimensions are in inches.
** Add 6" for Modulating Humidity Control or 8" for Hot Water Coils.*

Vertical & Multi-Position

Matching CB and F1, Air Conditioner Performance			
Condensing Unit	Air Handler	Nominal Capacity	SEER
CB-024	F1-024	24 MBH / 2 Tons	17.2
CB-036	F1-036	36 MBH / 3 Tons	15.5
CB-048	F1-048	48 MBH / 4 Tons	15.6
CB-060	F1-060	60 MBH / 5 Tons	14.6

Matching CB and F1, Heat Pump Performance				
Condensing Unit	Air Handler	Nominal Capacity	SEER	HSPF
CB-024	F1-024	24 MBH / 2 Tons	16.3	8.5
CB-036	F1-036	36 MBH / 3 Tons	14.8	8.5
CB-048	F1-048	48 MBH / 4 Tons	14.7	8.7
CB-060	F1-060	60 MBH / 5 Tons	14.4	8.3

Split System Heat Pump

Energy efficient heating option that allows a split system to be able to provide on demand cooling and heating with the refrigeration circuit. Option is available as a matched split system with a CB Series condensing unit and F1 Series air handler.

Split System Modulating Humidity Control

This premier option provides energy efficient dehumidification, even at low sensible heat loads, with modulating valves that reduce temperature swings. During the dehumidification mode of operation the system uses the valves to control the amount of reheat provided by the factory installed reheat coil, thus dehumidifying the air while at the same time supplying comfortable, room temperature air. Moisture related indoor air quality issues, such as mold growth, condensation, and structural deterioration, are minimized, or eliminated, by reducing the space humidity while enhancing occupant comfort.

ECM Supply Blower Motor

Factory installed and configured ECM motor for each F1 Series model and can be field configured and optimized based on the local climate and application. ECM motor technology is both reliable and ultra-high efficiency, dramatically increasing the system's SEER ratings. The electronically controlled motor quietly varies the fan speed to maintain air volume, provide exceptional temperature control, and consistent comfort.

AAON Environmentally Friendly HVAC Product Family

Customer Commitment – AAON encourages environmentally responsible design by incorporating many energy saving features into our superior heating and cooling products. In addition to energy efficiency, AAON also offers environmentally friendly R-410A refrigerant capability in all our cooling and heat pump equipment. As countries throughout the world phase out CFC and HCFC refrigerants, R-410A is becoming the global standard and AAON is leading the way!

Rooftop Units


2 - 5 Tons


2 - 30 Tons


26 - 70 Tons


45 - 230 Tons

Condensing Units


2 - 5 Tons
(Horizontal)

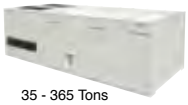

2 - 5 Tons


6 - 60 Tons


45 - 230 Tons

Air-Cooled or Evaporative-Cooled Chiller


35 - 365 Tons

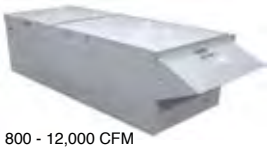

35 - 365 Tons

Boiler


500 - 6,000 MBH

Outdoor Air Handling Units


800 - 2,000 CFM


800 - 12,000 CFM


10,400 - 28,000 CFM


18,000 - 68,000 CFM

Indoor Air Handling Units


1,000 - 16,000 CFM


16,000 - 51,500 CFM


800 - 10,000 CFM


800 - 2,000 CFM

Custom Indoor or Outdoor Air Handling Units


Direct Fired
1,500 - 100,000+ CFM


1,500 - 218,000 CFM • Indirect Fired


1,500 - 120,000+ CFM