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A Commercial Apartment Complex

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A Commercial Apartment Complex

Honors Project in Mechanical Engineering

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Acknowledgments

I would like to thank the mechanical engineering department of BlueStreak Consulting for their expertise and input into the completion of this work, specifically Dan Austrian and Brian Rice. I would also like to thank Dr. Guo-Xiang Wang for his aid in my research and work.

Abstract

A cost-efficient outcome for a design project is the best way for the reviewer, the engineers, and the designers to meet their goals and requirements. Throughout this report the benefits of different outcomes and ways of design will be analyzed and expanded upon.

Many systems will be compared with each other in order to find the best fit for the specific client's needs. These systems cover in-depth new and used heating, cooling, and plumbing systems and equipment. Navigating how to guide clients unfamiliar with the way engineering design works will also be explored.

Work for this design project was completed in 2019 while I was an intern. Having since completed my undergraduate curriculum, I realized this project is full of previously overlooked concepts and decisions that I now understand the thought process behind.

I have experienced incredible academic impact by completing this honors research report. It will make me a more fruitful employee, a better consulting engineer, and more confident in the culmination of my classroom and fieldwork experience.

Table of Contents

Nomenclature

MEP	mechanical, electrical, plumbing

List of Illustrations

Introduction

Background:

I have been fortunate enough to intern at BlueStreak Consulting throughout my efforts toward completion of a Bachelor of Science in Mechanical Engineering. BlueStreak Consulting is comprised of mechanical, electrical, plumbing, and structural engineers and designers specialized in construction design, production, development, and construction administration services. Throughout my several internships, I worked alongside and learned from many Professional Engineers on commercial, retail, and residential projects. Residential projects cover a broad range of project types including single and double family houses, senior living complexes, and apartment complexes. On one incredibly intensive residential project, I logged over eighty hours of mechanical and plumbing work. This project, "A Commercial Apartment Complex", was a twenty-six-building apartment complex in a desert region of the United States. Working over a series of five months, I had to quickly learn and grasp concepts (several of which were previously unknown to me) covering a range of equipment including but not limited to: ductless mini-split wall mounted heating units, outdoor condensing units, baseboard radiation units, heating boilers, tank water heaters, storage tanks, hose bibbs, and combustion air outlets.

Inspiration:

After spending so many hours working on the mechanical design of the apartment complex, upon completion I realized that I rushed through many of the concepts in order to keep up with the work and how much it changed over time. I saw this report as an opportunity to build upon and add to my undergraduate experience and knowledge. Since completing the apartment complex project on co-op, I have taken classes like Heat Transfer, Fluid Mechanics, and Design

of Mechanical Components. Analyzing the work I have done with the knowledge I have gained from engineering curriculum will greatly benefit me and my future career when dealing with similar projects.

Design Problem and Objectives

Throughout the design drafting of the apartment complex, the reviewer made a myriad of changes to the scope of the project. These changes stemmed from wanting to be cost efficient, but there are different ways in which that can be achieved based on the reviewer's wants and also the needs of the engineer (in regard to safety, ethics, and meeting code requirements).

In the already built apartment complex, there was existing equipment (mechanical and plumbing) that was either refurbished for use or replaced under the project's scope. A large part of the constant changes in the scope was what was deemed to need refurbishing or to need replacing.

Within this report, the objective is to display and compare different scenarios of refurbished equipment and replaced equipment that were considered or drafted throughout the mechanical, electrical, and plumbing (MEP) design of the apartment complex. The main scenarios covered will include: when the client had the best equipment (high-end outcome) and why, when the client had the cheapest equipment (low-end outcome) and why, when the client had the best equipment while also being cost efficient (cost-efficient outcome) and why, and how an engineer can give the best offer to a client to ensure their needs are met.

Detailed Design Process Documentation

In order to establish the scope of the apartment complex project the reviewers, architects, and engineers all met on site to survey the site conditions. As previously stated, the scope changed over and over again throughout this project's design. Three scopes/outcomes will be analyzed that were relevant toward the beginning, middle, and end of the project.

Each building within the apartment complex had apartment units and a boiler room on each floor. Additionally, one 4-plex apartment building had a laundry room attached to its first floor, and one 6-plex apartment building had the leasing office attached to it.

The existing equipment and their locations in each building was as follows: water heater (boiler room), baseboard radiation (apartment units, leasing office, and laundry), heating units (apartment units), exhaust fans (apartment units), boiler (boiler room), storage tank (boiler room), and hose bibbs (outside walls).

High-End Outcome

The scope of this outcome was created shortly after the team site visit, when it is easy to look at equipment and think that it should be replaced with no problem. It is called the high-end outcome because it represents the scope of which design gave the client the best equipment without being cost conscious.

Throughout each apartment building, every floor had a boiler room with an existing water heater, storage tank, and boiler in it. Once the reviewers on the site visit saw this equipment and the age of it, they swiftly decided that they wanted to replace all of it. In early drafts of the project, all of this equipment was called out to be removed and replaced. Early model considerations for the equipment were Bradford White and Lochinvar. The reviewer also

requested that the existing tank type water heaters be replaced with tankless water heaters. In addition to all of the equipment being replaced, the function of some of them was also going to be changed. The reviewer wanted the new storage tanks to be piped to new glycol hot-water-generating Heliodyne solar panels mounted on the roof of every building.

When walking through the apartment units individually, the reviewer expressed interest in removing and replacing all of the baseboard radiation in every single apartment unit in every building. In addition, the reviewer wanted to remove the existing apartment unit heating units and exhaust fans and replace them with new ductless mini-splits and new exhaust fans.

Lastly, the reviewer expressed interest in replacing all hose-bibbs of every building and installing new outdoor condensing units with refrigerant piping piped through the crawl spaces of the apartment units, laundry room, and leasing office.

On design documents, two versions of each drawing had to be made: one for demolition, and one for new equipment. Everything that was to be removed had to be called out as such, and the models of the replacements had to be identified either on the drawing or in the schedules of the drawing.

This can clearly be called the high-end outcome because the client and reviewer were trying to install brand new equipment in almost every aspect of the mechanical and plumbing design. While this is the safest, most efficient, and best quality option, it led to an upfront cost that the client and reviewer did not want to commit to. The introduction of solar energy contributed largely to this; while it was the most environmentally conscious option, it was also the most expensive. This outcome, with all of the new equipment, greatly reduced the chance of maintenance issues, breakage issues, and tenant issues. Unlike working with the existing equipment, the new equipment would likely not show any problems in its first years of life cycle.

Overall, this outcome presented the reviewer with the best layout of upfront cost in the long and short run.

Low-End Outcome

The scope of this outcome was created after the reviewers were presented with the high-end outcome and did not approve of it or feel it worked for them. It is called the low-end outcome because it represents the scope of which design gave the client the cheapest equipment.

Throughout the twenty-six apartment buildings, each boiler room had an existing water heater, boiler, and storage tank. The existing water heaters were made by either Lochinvar, Amtrol, Advance Metalpres, or Superstor Ultra, and installed between 1991 and 2007. The existing boilers were made by either Lochinvar, Raypak, Amtrol, or Weil Mclain, and installed in the same time frame as the water heaters. The existing storage tanks were likely installed around the same time.

The remaining existing equipment – hose bibbs, exhaust fans, and baseboard radiation – all had manufacture and install dates that were unknown. A few units of each were reported to be not working and noted to need maintenance work or replacement per the site visit survey.

On design documents, all of the existing equipment was shown on the building plans as accurately as possible. If there was a specific piece of equipment that needed to be fixed, it was called out on the document with a suggested replacement if needed. The rest of the equipment that did not need fixed or replaced was labeled as existing to remain.

This can clearly be called the low-end outcome because the client and reviewer were trying to reuse every piece of existing equipment possible regardless of the condition. While this was the most frugal option at first glance, this could have led to maintenance issues, breakage

issues, and tenant issues when the apartments opened. Given that the install and manufacturing dates of some of the equipment was unknown and the rest ranged from 1991 to 2007 means that it is a guessing game as to when some equipment will give in to the effects of age and wear. It is impossible to know whether this could happen to many pieces of equipment at once or happen one at a time. Regardless, it is a risk to allow aged equipment to operate past when it ethically and safely should, and a dice roll on future unexpected/untimely expenses to the client that will ultimately come with it.

Cost-Efficient Outcome

The scope of this outcome was what made it to final drafts and construction documents. It is called the cost-efficient outcome because it represents the scope of which design gave the client the best equipment while also being cost efficient. Under the direction of the project engineers, the reviewer chose to combine the high-end and low-end outcomes in order to create the most efficient but cost-conscious outcome possible.

In doing so, the final verdict on the equipment was: existing baseboard radiation to remain, new ductless mini-splits and new exhaust fans in the apartment units and leasing office/laundry, new condensing units outside with new refrigerant piping, remove and replace existing boiler, remove and replace existing water heater, remove existing storage tank, and refurbish all hose-bibbs.

The reviewer had to make cost-conscious cuts and sacrifices to pick which equipment needed to be replaced the most and which equipment could remain. This outcome was largely guided by the experienced engineers on the project who know and analyze the efficiencies, power requirements, and long-term effects of the equipment.

Much of the back and forth with the reviewer on this project could have been avoided if the engineers had been given the opportunity to come up with a cost analysis *prior* to the reviewer listing the wants and needs of the project, and if drafting documents were not created until the final outcome was determined.

Due to the several alternate outcomes, there were three drafted document sets that showed the reviewer what each outcome would look like. In viewing these documents from an engineering perspective, it is imperative to analyze each piece of equipment and compare and contrast the advantages and disadvantages of each option. Knowing how to do this ahead of time will increase productivity, efficiency, and effectiveness.

Results

After originally planning and committing to the high-end outcome and then switching to the low-end outcome, the client/reviewer ultimately decided on the cost-efficient outcome for the final design of the project. The following figures show side by side comparisons of the design drafts for every outcome that was considered by the client:

BOILER ROOM:

High-end:

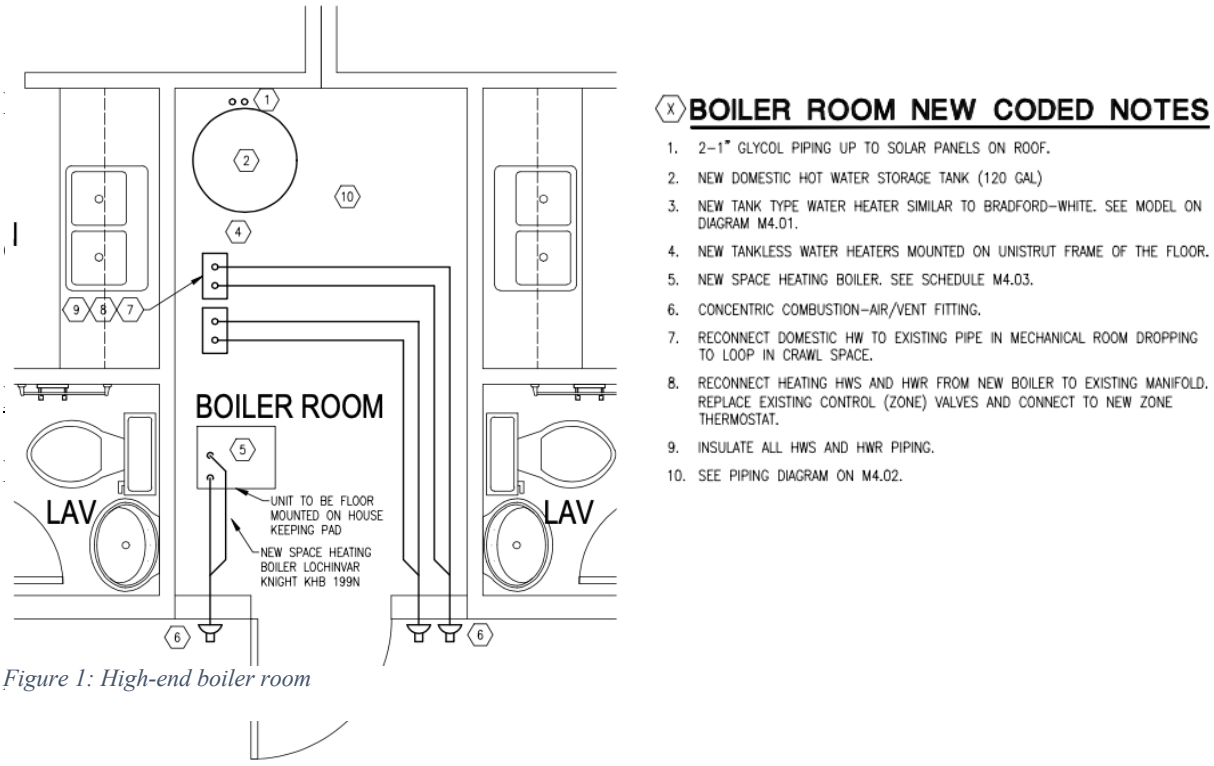


Figure 1: High-end boiler room

Low-end:

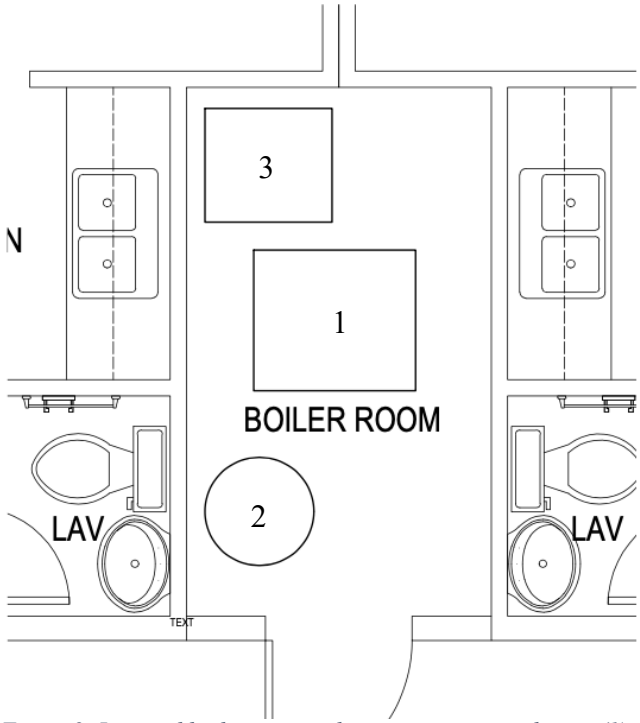


Figure 2: Low-end boiler room – shows existing water heater (1), storage tank (2), and boiler (3).

Cost-Efficient:

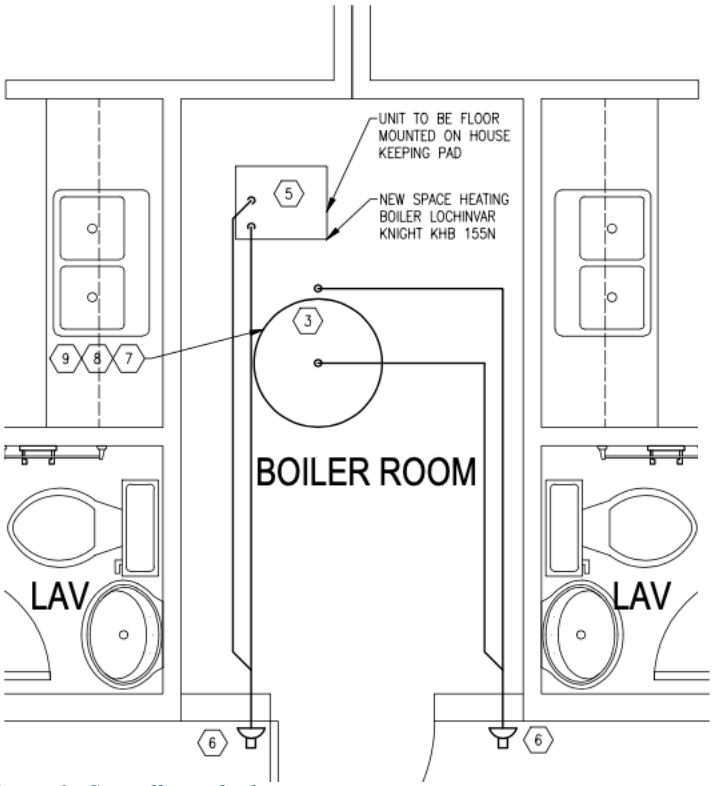


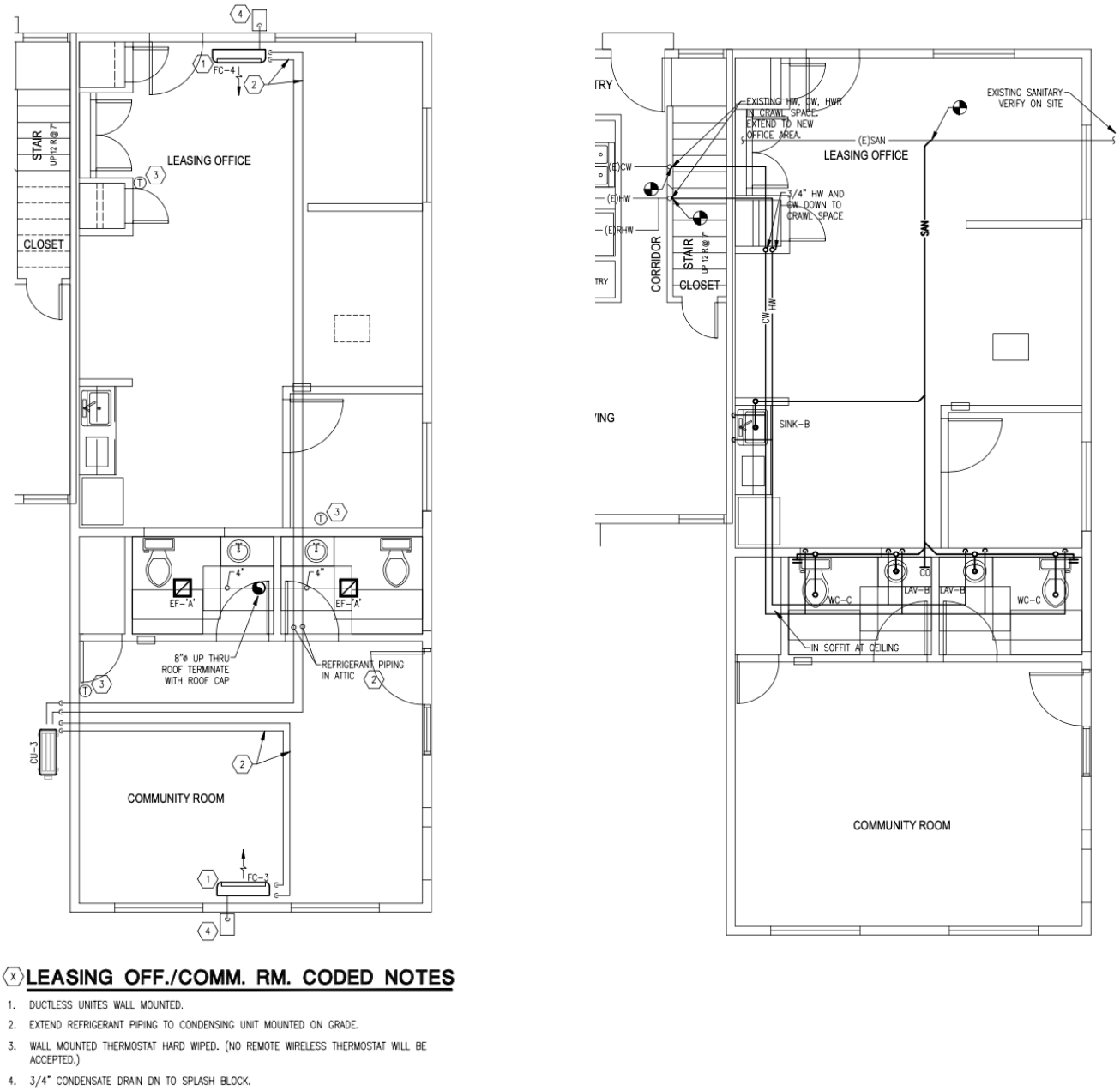
Figure 3: Cost-efficient boiler room

(X) BOILER ROOM NEW CODED NOTES

1. NOT USED.
2. NOT USED.
3. NEW TANK TYPE WATER HEATER BASIS OF DESIGN A.O. SMITH CYCLONE MXI-BTH-150.
4. NOT USED.
5. NEW SPACE HEATING BOILER. SEE SCHEDULE M4.02.
6. CONCENTRIC COMBUSTION-AIR/VENT FITTING.
7. RECONNECT DOMESTIC HW TO EXISTING PIPE IN MECHANICAL ROOM DROPPING TO LOOP IN CRAWL SPACE.
8. RECONNECT HEATING HWS AND HWR FROM NEW BOILER TO EXISTING MANIFOLD. REPLACE EXISTING CONTROL (ZONE) VALVES AND CONNECT TO NEW ZONE THERMOSTAT.
9. INSULATE ALL HWS AND HWR PIPING IN BOILER ROOM.
10. SEE PIPING DIAGRAM ON M4.01.

LEASING OFFICE

High-end:



X LEASING OFF./COMM. RM. CODED NOTES

1. DUCTLESS UNITES WALL MOUNTED.
2. EXTEND REFRIGERANT PIPING TO CONDENSING UNIT MOUNTED ON GRADE.
3. WALL MOUNTED THERMOSTAT HARD WIPED. (NO REMOTE WIRELESS THERMOSTAT WILL BE ACCEPTED.)
4. 3/4" CONDENSATE DRAIN DN TO SPLASH BLOCK.

Figure 4: High-end leasing office

Low-end:

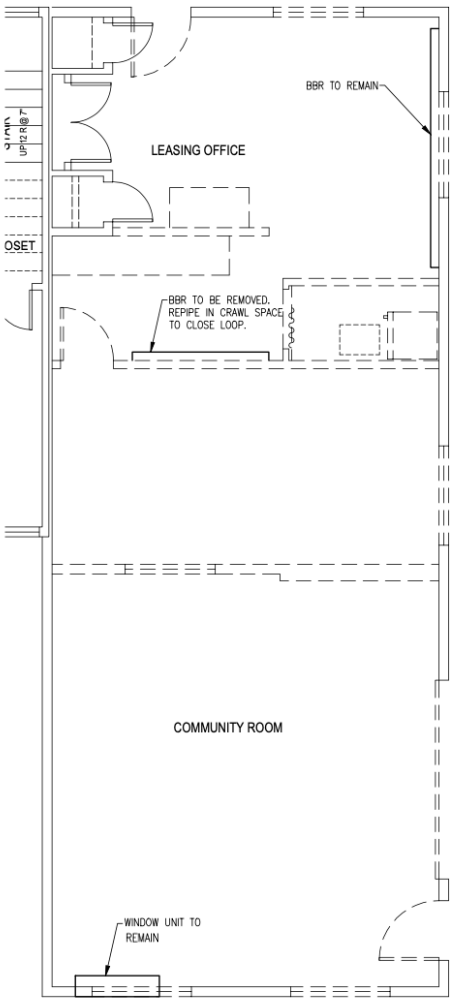
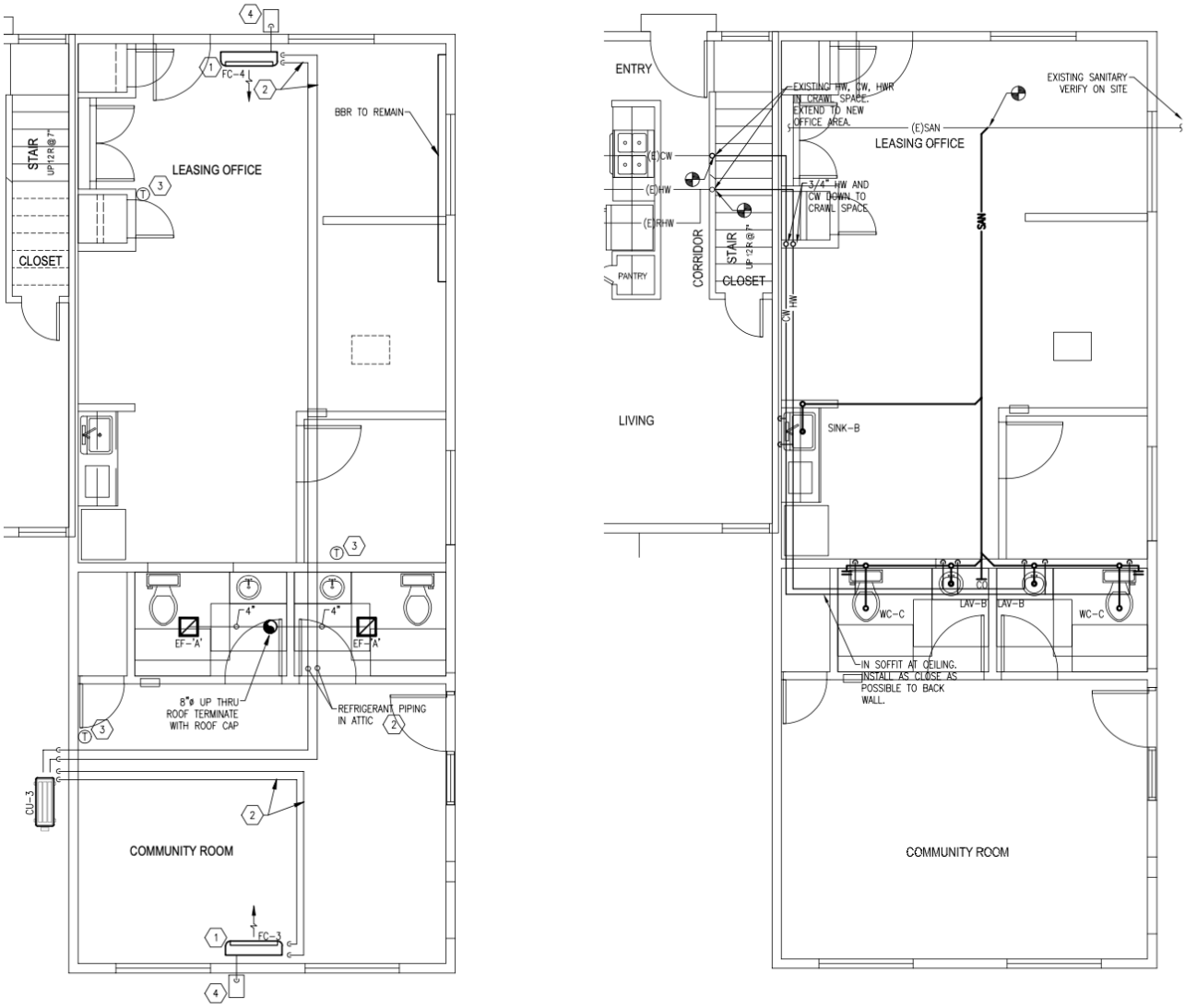


Figure 5: Low-end leasing office

Cost-Efficient:



⟨X⟩ LEASING OFF./COMM. RM. CODED NOTES

1. DUCTLESS UNITES WALL MOUNTED.
2. EXTEND REFRIGERANT PIPING TO CONDENSING UNIT MOUNTED ON GRADE.
3. WALL MOUNTED WIRELESS THERMOSTAT. MOUNTED IN WALL CRADLE.
4. 3/4" CONDENSATE DRAIN DN TO SPLASH BLOCK.

Figure 6: Cost-efficient leasing office

LAUNDRY ROOM

High-end:

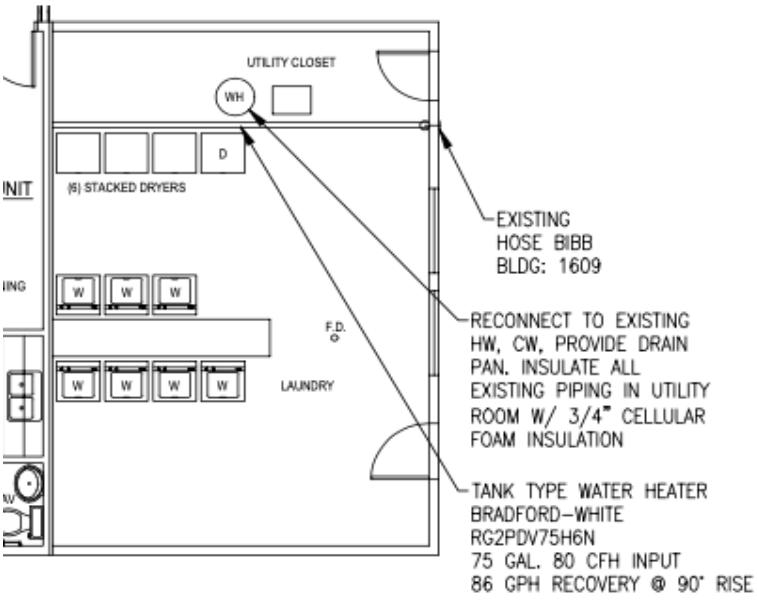


Figure 7: High-end laundry room

Low-end:

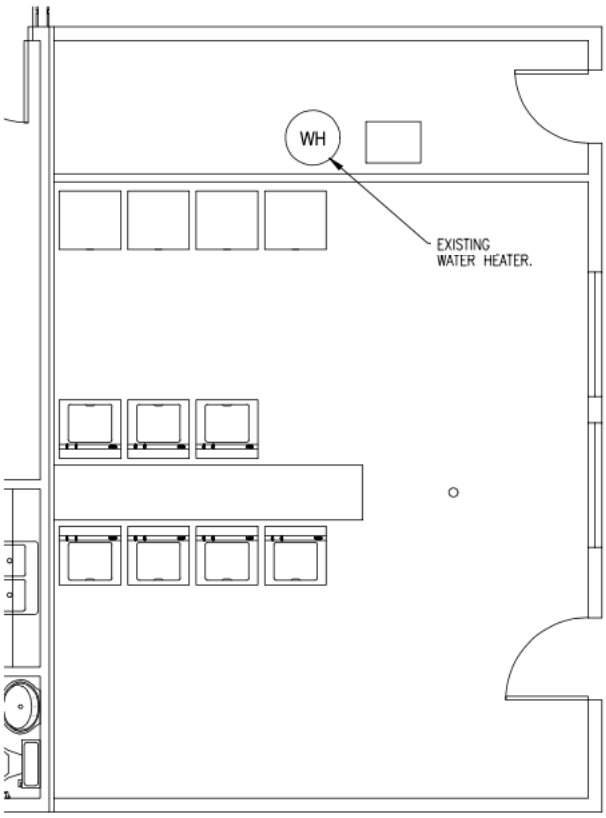


Figure 8: Low-end laundry room

Cost-Efficient:

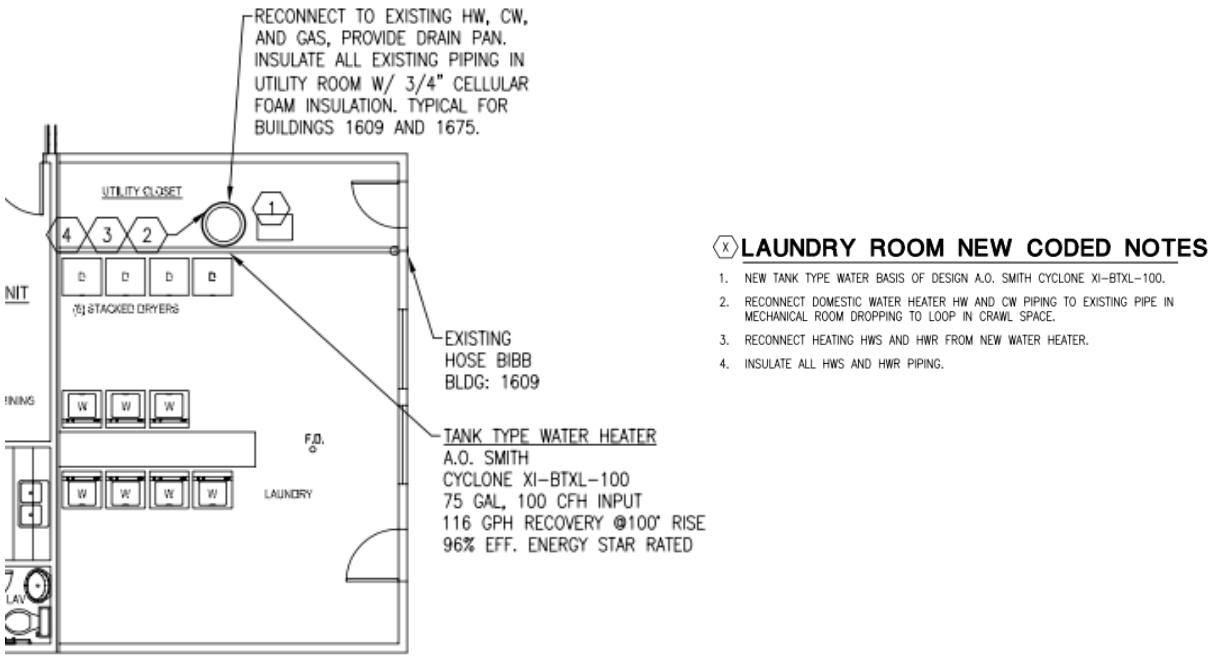


Figure 9: Cost-efficient laundry room

HOSE BIBBS

High-end and low-end not originally drafted

Cost-Efficient:

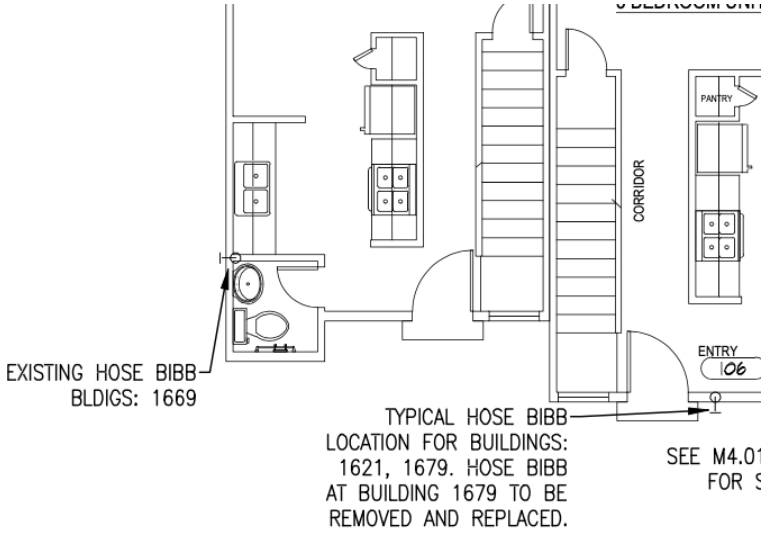


Figure 10: Cost-efficient hose-bibbs. Shows some existing to remain and some to be removed and replaced

UNITS

High-end:

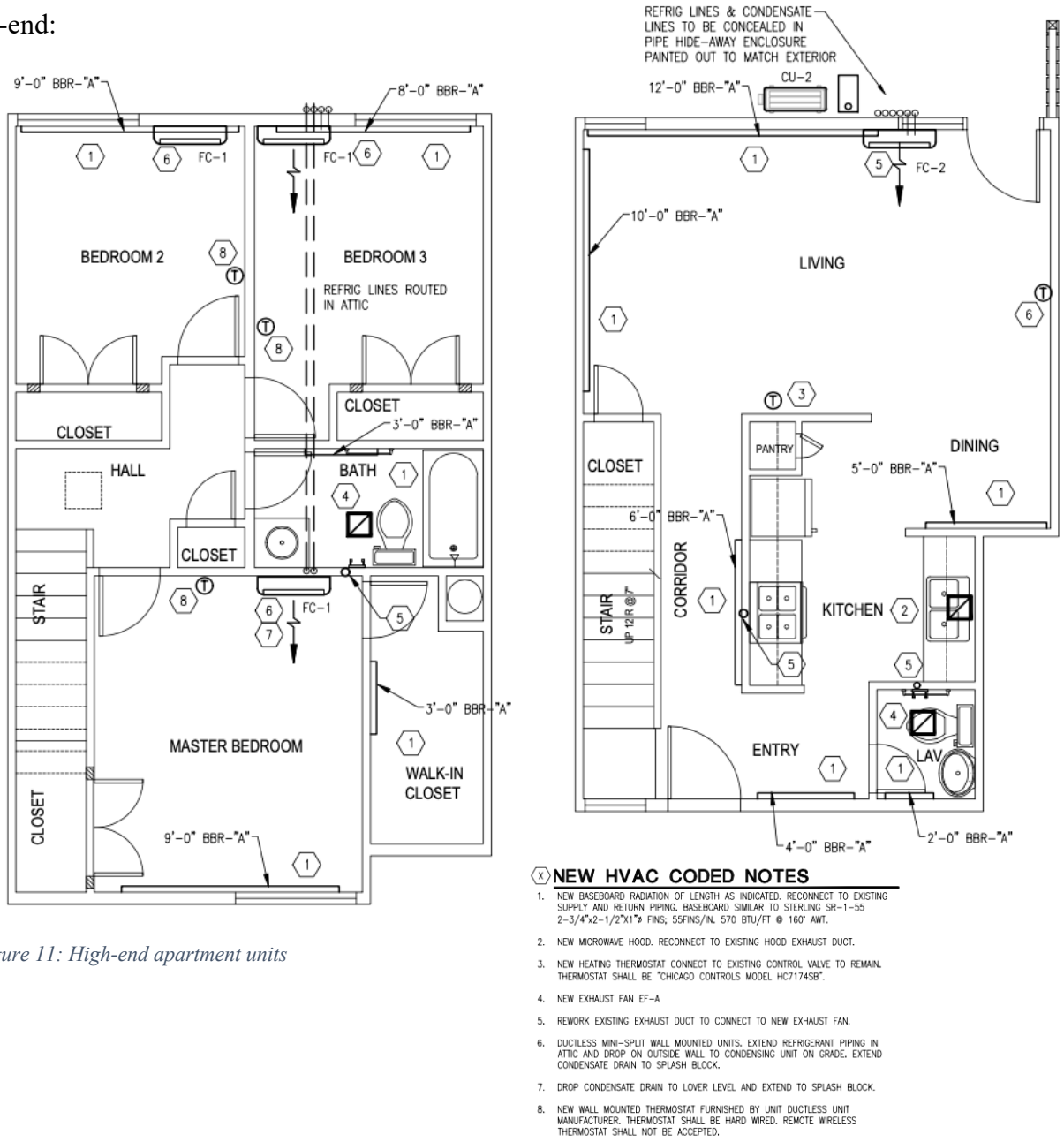


Figure 11: High-end apartment units

Low-end:

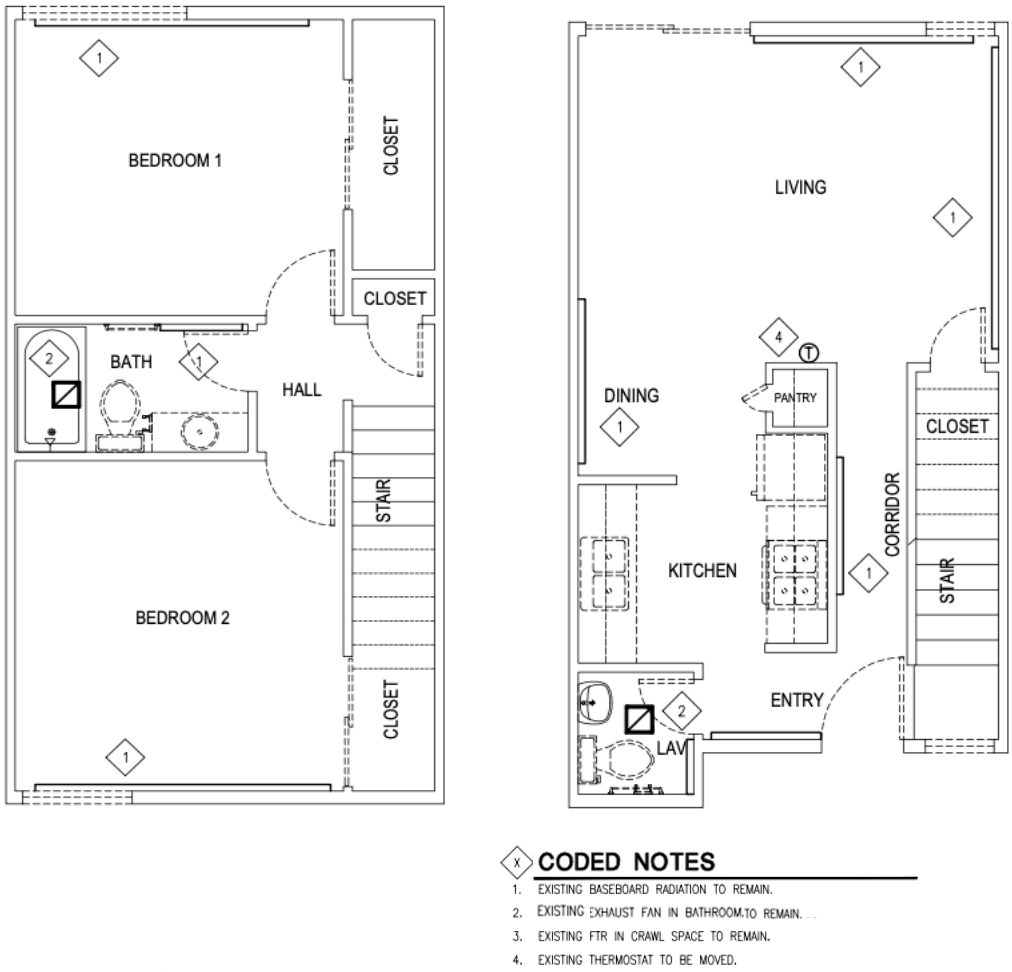


Figure 12: Low-end apartment units

Cost-Efficient:

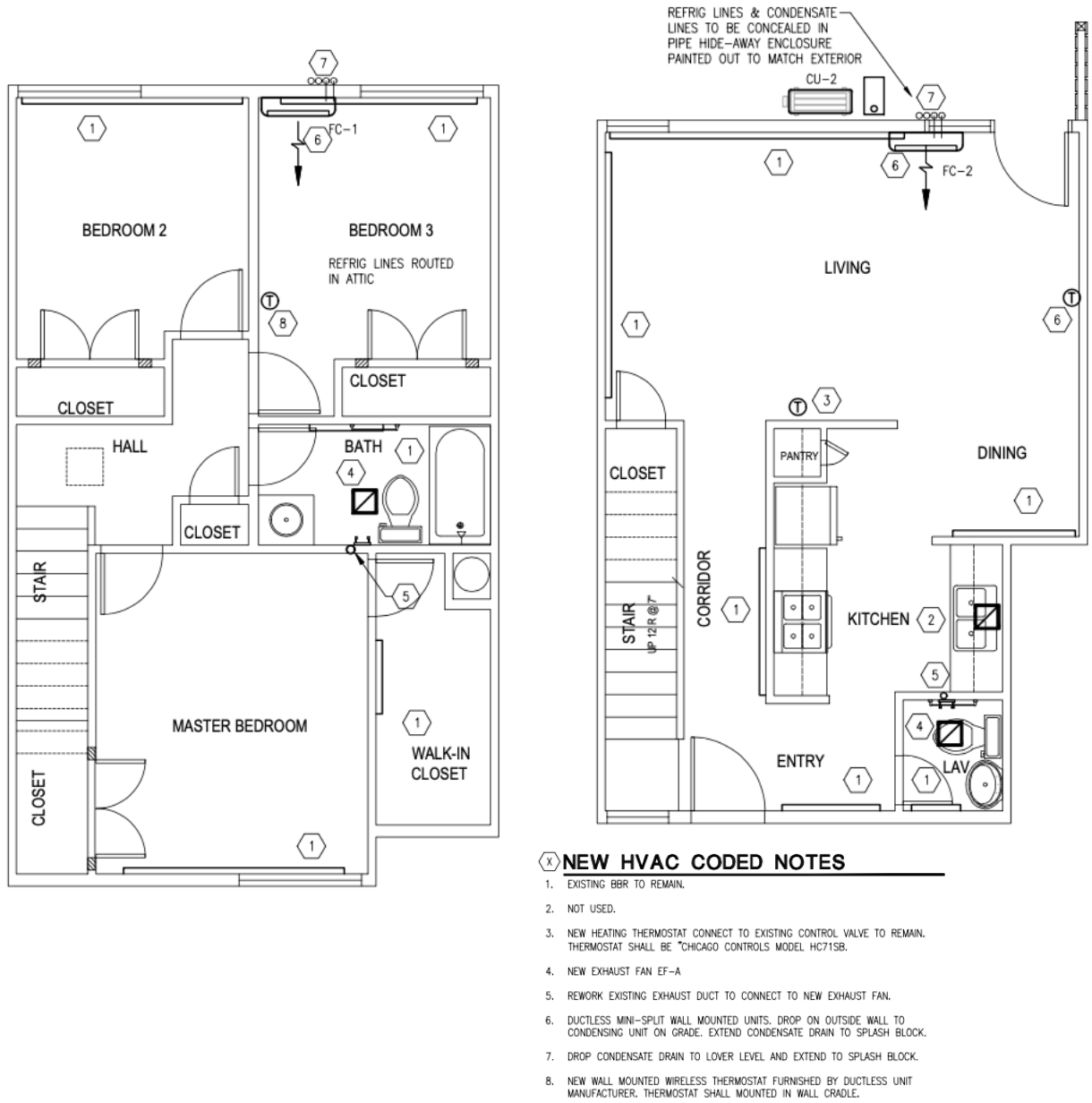


Figure 13: Cost-efficient apartment units

Discussion

As expected, the reviewer felt that the cost-efficient outcome was the best option. There are strong points and limitations for each option (high-end, low-end, and cost-efficient), as well as advantages to using certain equipment in each option over the other.

Boiler Room:

The high-end outcome offered a new Bradford White solar powered boiler, water tank, and a new storage tank. (See appendices for solar piping diagram vs. no solar) Hot water is near the top of the list for energy cost for residential buildings. Solar water heating can reduce this cost but adds other costs to the equation such as installation, maintenance, and higher quality equipment cost. The low-end outcome offered existing equipment with no real timeline of when repairs would have to be made.

Between the high-end outcome and the cost-efficient outcome, the reviewer debated between tank type gas water heaters and tankless electric water heaters. Tank type gas water heaters tend to have higher initial costs than an electric tankless water heater; however, they cost less to operate. This is what ultimately guided the reviewer's and engineer's decision to select an A.O. Smith tank model. The A.O. Smith model is ENERGY STAR qualified and has a spiral heat exchanger that keeps the hot combustion gases in the tank for a long period of time which creates a longer heat transfer cycle as compared to the Bradford White high-end outcome model and the Lochinvar low-end outcome model.

Leasing Office:

The high-end outcome offered a new condensing unit, new ductless mini-split with refrigerant piping, new baseboard radiation, and new exhaust fans. The low-end outcome offered the existing baseboard radiation and existing heating units.

The cost-efficient outcome ultimately offered the best solution with a new condensing unit, new ductless mini-split with refrigerant piping, existing baseboard radiation, and new exhaust fans. The new condensing units and ductless mini-splits made by SAMSUNG were decades ahead of what existed in the building, while also being up to modern code on energy and heating requirements.

Laundry:

The high-end outcome offered a new Bradford White water heater, new baseboard radiation, and new hose-bibb. The low-end outcome offered a Lochinvar existing water heater model, existing hose-bibb, and existing baseboard radiation.

The cost-efficient outcome offered a more efficient and cost-conscious A.O. Smith water heater model with existing hose-bibb and existing baseboard radiation.

Hose-Bibbs:

The cost-efficient outcome offered a combination of existing hose-bibbs that did not need replacement and new hose-bibbs that were to be installed after removing of existing ones that were unable to be refurbished.

Units:

The high-end outcome offered new baseboard radiation, new ductless mini-split, new exhaust fans, and a new condensing unit. The low-end outcome offered existing baseboard radiation, existing heating units, and existing exhaust fans.

The cost-efficient outcome offered existing baseboard radiation, new ductless mini-split, new exhaust fans, and a new condensing unit all identical to what was designed in the leasing office.

Ethical and Safety Considerations: Provide information on any ethical considerations that govern the product specifications you have developed or that need to be taken into account in potentially marketing the product.

The largest ethical and safety considerations within this project were whether or not existing equipment should be reused knowing very little about the specifications of the equipment and being unable to travel across the country to look at it personally. On the site visit, it can be determined if a piece of equipment is in need of replacement if it is truly near the end of its life cycle. However, not all equipment presents such a black-and-white problem and answer. A piece of equipment could look great on the outside but be completely dysfunctional and unsafe on the inside. When completing a project for a reviewer that is analyzing a low-end outcome where the equipment barely meets code and the reviewer is looking to spend the least amount of money possible, it is the engineer's job to be knowledgeable about what is safe and ethically suitable. (See appendices for code and product specifications referenced throughout the project and report analyzation.)

This is where knowledge from classes such as fluid mechanics, heat transfer, and analysis of mechanical components must be recalled. An engineer has to explain to a reviewer why they cannot move forward with certain equipment, why they can move forward with others, and why maybe a different piece of equipment might better suit the problem at hand.

It was at this point of this project where I, as an intern, could not fully meet the role of engineer. It is only now that I can look back and understand why it would not be wise to leave ten-to-fifteen-year-old equipment piping in a building, why it would be wise to reuse a perfectly working exhaust fan even though it might be aged as well, and why it is wise to choose one piece

of equipment over the other on the grounds of energy efficiency, heat transfer properties, and flow properties.

With a now advanced understanding of concepts such as flow, conduction, convection, radiation, machinery, and equipment life cycle, I look at this project that I completed in a completely different way. I see the underlying responsibilities and thought processes of the engineers involved and understand why many decisions were made.

Conclusion

The cost-efficient outcome for the equipment on this project was the best avenue for the reviewer, the engineers, and the designers. With the cost-efficient outcome, every party achieves what they are after: the reviewers get reliable equipment at a low cost, the engineers get a safe and code compliant design, and the designers get productive and efficient scopes.

A vast knowledge of mechanical equipment, equipment properties, and mechanical engineering curriculum concepts is imperative to aide in analyzing and guiding an involved reviewer through the engineering perspective of what equipment could be reused and what should be replaced on MEP documents.

With the completion of my undergraduate program and encompassed review of my internship projects, I have experienced incredible academic impact. Without a doubt, this will make me a more productive employee, better consulting engineer, and more likely to receive and volunteer for more projects where the equipment studied in this report is used and debated.

References

[1] AO Smith BTH-150 Water Heater - Features and Sequence of Operations. (2018, November 21). Retrieved August 08, 2020, from https://blog.wallingfordsales.com/ao-smith-bth-150-water-heater/

[2] Bergman, T. L., Lavine, A. S., Incropera, F. P., & Dewitt, D. P. (2011). *Introduction to heat transfer*. Hoboken, NJ: Wiley.

[3] Fox, R. W., McDonald, A. T., & Pritchard, P. J. (2004). *Introduction to fluid mechanics*. New York: Wiley.

Appendices

A) Solar Piping Diagram

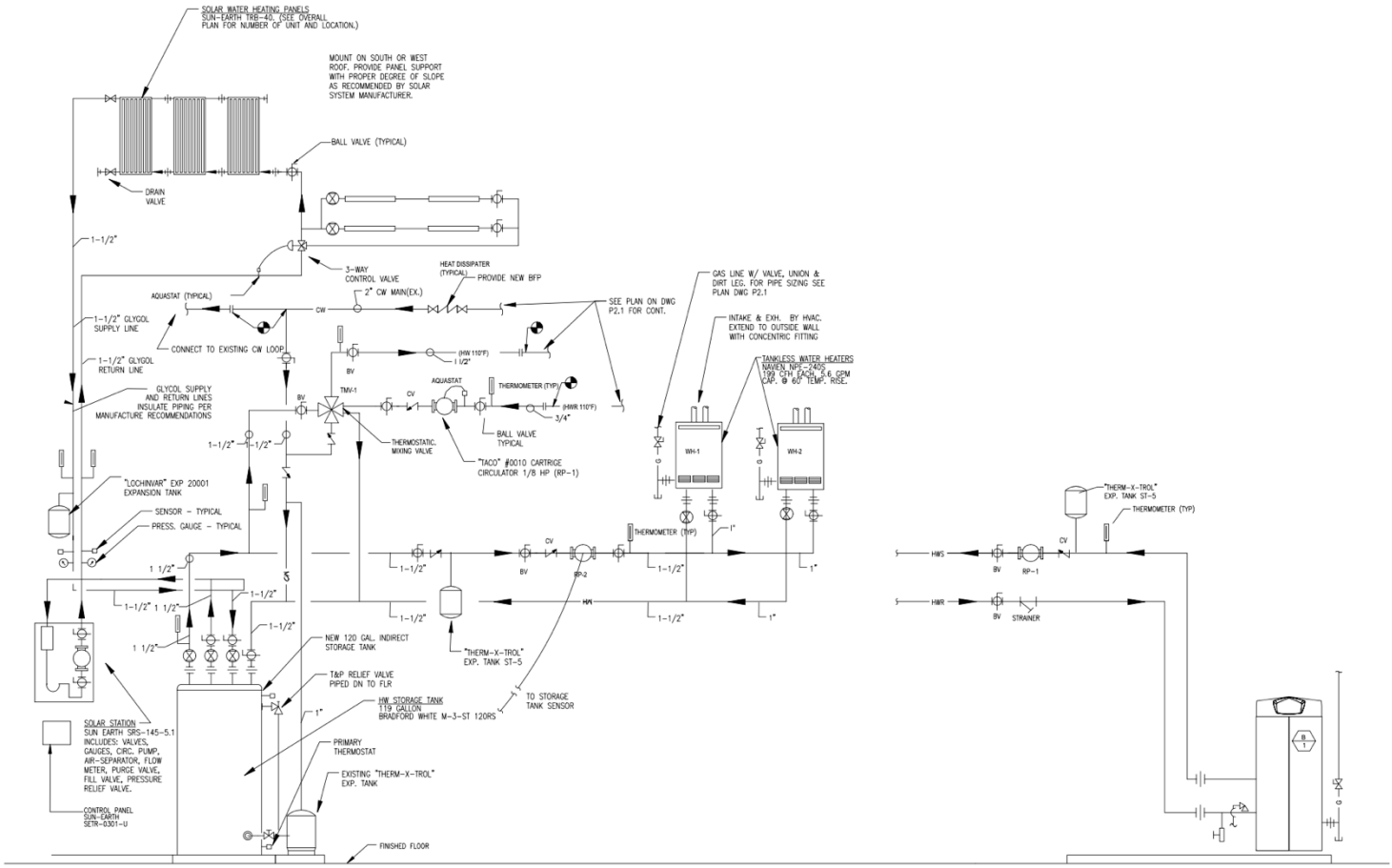
B) Non-solar Piping Diagram

C) Bradford White Product Specifications

D) SAMSUNG Product Specifications

E) Mechanical and Plumbing Code

A)



DOMESTIC SOLAR HOT WATER & STORAGE TANK PIPING DIAGRAM (ALTERNATE)
N.T.S.

(SEE PLANS FOR PIPE SIZES)

NOTE: PLUMBING CONTRACTOR TO PROVIDE TIMECLOCK TO CONTROL THE HOT WATER RECIRCULATION PUMP

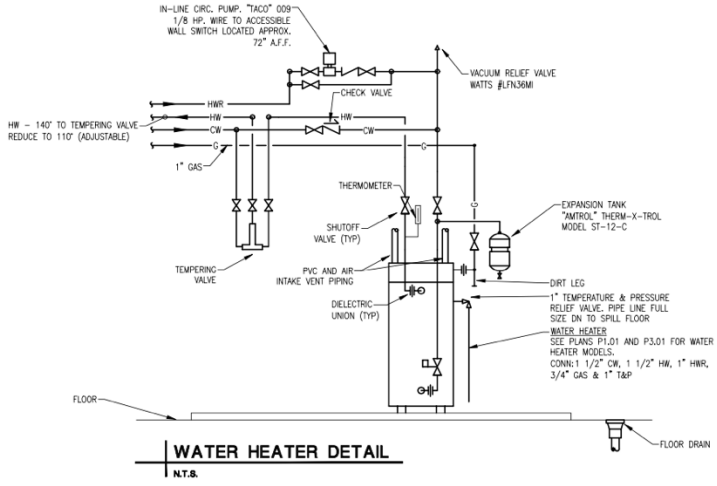
TMV-1 PIPING SHALL BE INSTALLED PER MANUFACTURE RECOMMDATION. TMV-1 TO BE SIZED BY THE PLUMBING CONTRACTOR.

PLUMBING CONTRACTOR TO MAKE FINAL CONNECTION TO WATER HEATERS.

REMOVE EXISTING BOILER TLUE FROM BOILER ROOM TO ROOF. INSTALL NEW PIPE CURB TO ALLOW NEW SOLAR SYSTEM SUPPLY AND RETURN PIPING TO DROP TO BOILER ROOM

HEATING BOILER PIPING DETAIL
N.T.S.

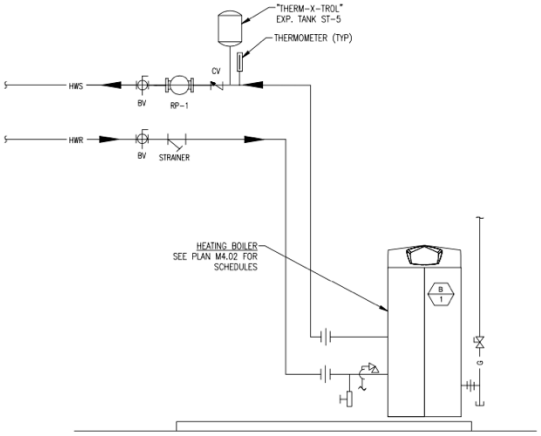
B)



WATER HEATER DETAIL

N.T.S.

NOTE:
1. WATER HEATER INSTALLATION TO COMPLY WITH STATE CODES AND LOCAL AUTHORITIES.
2. VACUUM RELIEF VALVE REQD ON BOTTOM FED WATER HEATER.
3. WATER HEATER WITH NON CIRCULATING SYSTEM SHALL HAVE HEAT TRAP ON CW & HW CONNECTIONS PER INTERNATIONAL ENERGY CODE.
4. CONTRACTOR TO COORDINATE POWER & VOLTAGE WITH ELECTRICAL CONTRACTOR.
5. INTAKE & EXHAUST BY HVAC. SEALED DIRECT VENT SIDEWALL PIPING SHALL BE PVC, ABS or CPVC AS RECOMMENDED BY MANUFACTURER.



HEATING BOILER PIPING DETAIL

N.T.S.

C)

BRADFORD WHITE®
WATER HEATERS

Residential Power Direct Vent Gas Water Heater

Photo is of
RG2PDV40S6N

The Power Direct Vent Models Feature:

- **ENERGY STAR® Qualified—**Some models meet or exceed requirements for ENERGY STAR® per the latest ENERGY STAR® criteria revision, as well as most utility rebate programs.
- **Bradford White ICON System™—**Intelligent gas control with spark to pilot ignition system eliminates the constant burning pilot. This results in savings of pilot gas during standby periods (120 VAC).
  - **Enhanced Performance—**Proprietary algorithms provide enhanced First Hour Rating and tighter temperature differential.
  - **Advanced Temperature Control System—**Microprocessor constantly monitors and controls burner operation to maintain consistent and accurate water temperature levels.
  - **Intelligent Diagnostics—**An exclusive green LED light prompts the installer during start-up and provides ten different diagnostic codes to assist in troubleshooting.
  - **Pilot On Indication—**Flashing green LED provides positive indication that pilot is on.
  - **Separate Immersed Thermowell—**High-strength advanced polymer composite thermowell provides isolation between electric temperature sensor and surrounding water. No need to drain the tank when removing gas valve.
- **Closed Combustion Venting System—**Power Direct Vent models are ideal for installations which lack sufficient air for combustion, such as new construction homes or additions which are tightly insulated. These models use a twin pipe system where combustion air is drawn from outside the building in one pipe, and combustion products are expelled to the outside in another pipe.
- **Cast Aluminum Air Intake Boot—**A cast molded air intake boot design provides exceptional durability during installation and operation.
- **Horizontal and Vertical Venting—**PVC, ABS, or CPVC. The equivalent feet of intake venting cannot be greater than the equivalent feet of exhaust venting.
- **Optional Concentric Vent Kit Termination—**Termination fitting provides for only one exit opening through a wall or roof. (Subtract 10ft. (3m) for intake pipe and 10ft. (3m) for exhaust pipe when calculating total vent length.)
- **Flammable Vapor Sensor—**Electronic sensor prevents burner operation if flammable vapors are detected. The sensor will also prevent operation if there is ongoing flammable vapors burning inside the combustion chamber (excluding RG2PDV75H6N).
- **Factory-Installed Hydrojet® Total Performance System—**Sediment reducing device that also increases first hour rating of hot water while minimizing temperature build-up in tank.
- **Vitraglas® Lining—**An exclusively engineered enamel formula that provides superior tank protection from the highly corrosive effects of hot water. This formula (Vitraglas®) is fused to the steel surface by firing at a temperature of over 1600°F (871°C).
- **Insulation System—**2" (51mm) Non-CFC foam insulation covers the sides and top of the tank, reducing heat loss. This results in less energy consumption, improved efficiencies, and jacket rigidity.
- **Water Connections—**3⁄4" (19mm) NPT factory-installed true dielectric fittings extend water heater life and simplify water line connections.
- **Side Connections—**3/4" (19mm) NPT tappings allow easy connections for space heating applications (Potable water only) (RG2PDV50H6N & RG2PDV75H6N only).
- **Factory Installed Heat Traps—**Design incorporates a flexible disk that reduces heat loss in piping and eliminates the potential for noise generation.
- **Protective Magnesium Anode Rod—**Provides added protection against corrosion for long-term, trouble-free service.
- **T&P Relief Valve—**Installed.
- **Low Restrictive Brass Drain Valve—**Durable tamper proof design.
- **NOx Emissions—**Less than 40 ng/J.

FEATURING:

ICON System
DEFENDER SAFETY SYSTEM
Hydrojet
AHRI CERTIFIED

6 or 10-Year Limited Tank Warranties / 6 or 10-Year Limited Warranty on Component Parts.
For more information on warranty, please visit www.bradfordwhite.com
For products installed in USA, Canada, and Puerto Rico. Some states do not allow limitations on warranties. See complete copy of the warranty included with the heater.

MANUFACTURED UNDER ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 5,682,666; 7,634,976; 5,660,165; 5,954,492; 6,056,542; 6,935,280; 5,372,185; 5,485,879; 5,574,822; 7,971,560; 7,992,526; 6,684,821; 7,334,419; 7,866,168; 7,270,087; 7,007,748; 5,596,952; 6,142,216; 7,699,026; 5,341,770; 7,337,517; 7,665,211; 7,665,210; 7,063,132; 7,063,133; 7,559,293; 7,900,589; 5,943,984; 8,082,888; 5,988,117; 7,621,238; 7,650,859; 5,761,379; 7,409,925; 5,277,171; 8,146,772; 7,458,341; 2,262,174. OTHER U.S. AND FOREIGN PATENT APPLICATIONS PENDING. CURRENT CANADIAN PATENTS: 2,314,845; 2,504,824; 2,108,186; 2,143,031; 2,409,271; 2,548,958; 2,112,515; 2,476,685; 2,239,007; 2,092,105; 2,107,012. **Defender Safety System®, Vitraglas® and Hydrojet® are registered trademarks of Bradford White® Corporation.**

1117-A-0119

Power Direct Vent Gas Water Heater

Power Direct Vent Models

NATURAL GAS AND LIQUID PROPANE GAS

Meet or exceed ASHRAE 90.1b (current standard) C.E.C. Listed
78% Recovery Efficiency

Model Number	Nominal Gal. Capacity U.S. Gal.	Nominal Gal. Capacity Imp. Gal.	DOE Rated Storage Volume (Gal.)	BTU/Hr. Input	LP BTU/Hr. Input	First Hour Rating (Gal.)	Uniform Energy Factor	Recovery at 90°F Rise* U.S. GPH	Recovery at 90°F Rise* Imp. GPH	Recovery at 90°F Rise* LP U.S. GPH	Recovery at 90°F Rise* LP Imp. GPH
★ RG2PDV40S6N	40	33	38	40,000	38,000	73	0.64	43	36	41	34
★ RG2PDV50S6N	50	42	48	40,000	38,000	80	0.68	43	36	41	34
★ RG2PDV50H6N	48	40	46	60,000	60,000	103	0.68	65	54	65	54
RG2PDV75H6N	75	62	72	80,000	78,000	134	0.69	86	72	84	70

Model Number	Nominal Liter Capacity	DOE Rated Storage Volume (Liters)	kW Input	LP kW Input	First Hour Rating (Liters)	Uniform Energy Factor	Recovery at 50°C Rise* Liters/ Hour	Recovery at 50°C Rise* LP Liters/ Hour
★ RG2PDV40S6N	151	144	11.7	11.1	277	0.64	163	155
★ RG2PDV50S6N	189	182	11.7	11.1	303	0.68	163	155
★ RG2PDV50H6N	182	174	17.6	17.6	390	0.68	246	246
RG2PDV75H6N	284	273	23.4	22.9	508	0.69	326	318

Model Number	A Floor to Exhaust Conn. in.	B Jacket Dia. in.	C Vent Size in.	D Floor to T&P Conn. in.	E Floor to Gas Conn. in.	F Floor to Top of Heater in.	G Floor to Water Conn. in.	H Depth in.	J C/L of Water Conn. in.	K Floor to Space Heating Inlet in.	L Floor to Space Heating Outlet in	M Water Conn. NPT in.	N Floor to Air Intake in.	R Space Heating Conn. Size in.	S Gas Conn. Size in.	Approx. Shipping Weight lbs.
★ RG2PDV40S6N	59 7/8	22	2 or 3	42 9/16	13 15/16	49 9/16	49 15/16	32 3/8	8	N/A	N/A	3/4	59 7/16	N/A	1/2	161
★ RG2PDV50S6N	60 7/8	24	2 or 3	43 1/16	13 15/16	50 9/16	52	34 3/8	8	N/A	N/A	3/4	60 7/16	N/A	1/2	192
★ RG2PDV50H6N	69 1/16	22	3 or 4	52 5/16	13 15/16	59 5/16	60 3/16	30 1/2	11	15 13/16	52 5/16	3/4	69 3/16	3/4	1/2	204
RG2PDV75H6N	69 1/2	26	3 or 4	51 15/16	13 15/16	59 11/16	60 3/16	35 3/8	11	16 11/16	51 15/16	3/4	69 9/16	3/4	1/2	291

Model Number	A Floor to Exhaust Conn. mm.	B Jacket Dia. mm.	C Vent Size mm.	D Floor to T&P Conn. mm.	E Floor to Gas Conn. mm.	F Floor to Top of Heater mm.	G Floor to Water Conn. mm.	H Depth mm.	J C/L of Water Conn. mm.	K Floor to Space Heating Inlet mm.	L Floor to Space Heating Outlet mm.	M Water Conn. NPT mm	N Floor to Air Intake mm.	R Space Heating Conn. Size mm.	S Gas Conn. Size mm.	Approx. Shipping Weight kg.
★ RG2PDV40S6N	1521	559	51 or 76	1081	354	1259	1268	822	203	N/A	N/A	19	1510	N/A	13	73
★ RG2PDV50S6N	1546	610	51 or 76	1094	354	1284	1321	873	203	N/A	N/A	19	1535	N/A	13	87
★ RG2PDV50H6N	1754	559	76 or 102	1329	354	1507	1529	775	279	402	1329	19	1757	19	13	93
RG2PDV75H6N	1765	660	76 or 102	1319	354	1516	1529	899	279	424	1319	19	1767	19	13	132

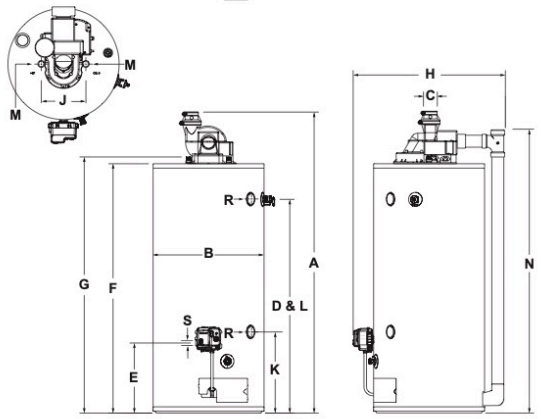
Propane models feature a Titanium Stabilized Stainless Steel propane burner. For Propane (LP) models change suffix "N" to "X".
For 10 year model, change suffix "6" to "10".

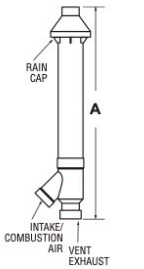
* Based on manufacturer's rated recovery efficiency.

110 VAC Required for Power Venting / 110 VAC, 60Hz., 3.1 Amperes.

Uniform Energy Factor and First Hour Rating is based on the latest AHRI directory listings.

★ = ENERGY STAR® Qualified.





Concentric Vent Kit Termination

2" Kit	A (in.)
P/N 239-44069-02	29 1/4
3" Kit	**A (in.)**
P/N 239-44069-01	36 1/4

2" Vent Pipe		RG2PDV40S6N RG2PDV50S6N
Max. Intake Length		35 ft.
Max. Exhaust Length		35 ft.
Min. Vent Length		7 ft.
Number	1	30 ft.
of	2	25 ft.
90° Elbows	3	20 ft.

3" Vent Pipe		RG2PDV40S6N RG2PDV50S6N	RG2PDV50H6N RG2PDV75H6N
Max. Intake Length		85 ft.	60 ft.
Max. Exhaust Length		85 ft.	60 ft.
Min. Vent Length		7 ft.	7 ft.
Number	1	80 ft.	55 ft.
of	2	75 ft.	50 ft.
90° Elbows	3	70 ft.	45 ft.

4" Vent Pipe		RG2PDV50H6N RG2PDV75H6N
Max. Intake Length		100 ft.
Max. Exhaust Length		100 ft.
Min. Vent Length		7 ft.
Number	1	95 ft.
of	2	90 ft.
90° Elbows	3	85 ft.

Subtract 5ft. (1.5m) for each additional 90° elbow.

General:

Meets NAECA or EPACT Requirements, as applicable.

All gas water heaters are certified at 300 PSI test pressure (2068 kPa) and 150 PSI working pressure (1034 kPa). All water connections are 3/4" NPT (19mm). All gas connections are 1/2" (13mm). All models design-certified by CSA International (formerly AGA/CGA), to meet ANSI standard Z21.10.1 (except RG2PDV75H6N = Z21.10.3) and peak performance rated.

Dimensions and specifications subject to change without notice in accordance with our policy of continuous product improvement.

Suitable for Water (Potable) Heating and Space Heating. Toxic chemicals, such as those used for boiler treatment, shall NEVER be introduced into this system. This unit may NEVER be connected to any existing heating system or component(s) previously used with a non-potable water heating appliance.

— BRADFORD WHITE IS —
AMERICAN STRONG

BRADFORD WHITE WATER HEATERS
Ambler, PA

For field service, contact your professional installer or local Bradford White sales representative.
Sales **800-523-2931** ■ Fax **215-641-1612**
Technical Support **800-334-3393** ■ Email **techserv@bradfordwhite.com**
Warranty **800-531-2111** ■ Email **warranty@bradfordwhite.com**
International: Telephone **1-215-641-9400** ■ Email **international@bradfordwhite.com / www.bradfordwhite.com**

Built to be the Best™

1117-A-0119

Printed in U.S.A.

BRADFORD WHITE®
WATER HEATERS

Residential Ultra Low NOx High Input Gas Water Heater

Photo is of
URG250H6N

The Atmospheric Vent High Input Models Feature:

- **Bradford White ICON System®*—**Intelligent gas control with proven millivolt powered technology and built-in piezo igniter. A standard, off-the-shelf thermopile converts heat energy from the pilot flame into electrical energy to operate the gas valve and microprocessor. No need for external electricity.
  - **Enhanced Performance—**Proprietary algorithms provide enhanced First Hour Rating and tighter temperature differential.
  - **Advanced Temperature Control System—**Microprocessor controls burner operation for consistent and accurate water temperature levels up to 160°F (71°C).
  - **Intelligent Diagnostics—**Exclusive multicolor LED light indicates operation status/ service required.
- **Defender Combustion Chamber—**Incorporates the Advanced ScreenLok® Technology Flame Arrestor and large split-door design to prevent ignition of flammable vapors outside the water heater (URG250H6N only).
- **Ultra Low NOx Burner with Primary and Secondary Air Distribution Devices—** Ensures proper air to gas ratio for reduction of NOx generated by the combustion process.
- **Digital Thermal Sensor and Resettable Thermal Switch—**Coordinates with self diagnostic control to prevent water heater operation when needed (URG250H6N only).
- **Maintenance-Free—**No regular cleaning of air inlet openings or flame arrestor is required under normal conditions (URG250H6N only).
- **Sight Window—**Offers a view into the combustion chamber to observe the operation of the pilot and burner.
- **Factory-Installed Hydrojet® Total Performance System—**Sediment reducing device that also increases first hour rating of hot water while minimizing temperature build-up in tank.
- **Vitraglas® Lining—**An exclusively engineered enamel formula that provides superior tank protection from the highly corrosive effects of hot water. This formula (Vitraglas®) is fused to the steel surface by firing at a temperature of over 1600°F (871°C).
- **Side Connections—**3/4" (19mm) NPT tappings allow an easy connection for space heating applications.
- **Insulation System—**Non-CFC foam covers the sides and top of the tank, reducing heat loss. This results in less energy consumption, improved efficiencies, and jacket rigidity.
- **Pedestal Base—**Rugged and durable base allows easy transport and positioning while providing corrosion-resistant contact with floor (URG250H6N / URG275H6N only).
- **Water Connections—**Factory-installed true dielectric fittings extend water heater life and simplify water line connections.
- **Factory-Installed Heat Traps—**Design incorporates a flexible disk that reduces heat loss in piping and eliminates the potential for noise generation.
- **Protective Magnesium Anode Rod—**Provides added protection against corrosion for long-term, trouble-free service.
- **4" (107mm) "Snap Lock" Draft Diverter**.
- **T&P Relief Valve—**Installed.
- **Low Restrictive Brass Drain Valve—**Durable tamper proof design.
- **Design Certified by CSA International (formerly AGA/CGA).**
- **URG250H6N complies with the latest Ultra Low NOx requirement (10 ng/J NOx limit)**
  URG275H6N / URG2100H6N comply with (14 ng/J NOx limit).

FEATURING:

ICON System

Eco DEFENDER Ultra Low NOx Series

Hydrojet

AUDI CERTIFIED

6 or 10-Year Limited Tank Warranties / 6 or 10-Year Limited Warranty on Component Parts.
For more information on warranty, please visit www.bradfordwhite.com
For products installed in USA, Canada, and Puerto Rico. Some states do not allow limitations on warranties. See complete copy of the warranty included with the heater.

1114-B-0319

Residential Ultra Low NOx High Input Gas Water Heater

Ultra Low NOx Models

NATURAL GAS

Meet or exceed ASHRAE 90.1b (current standard) C.E.C. Listed
Recovery efficiency ranging up to 79%

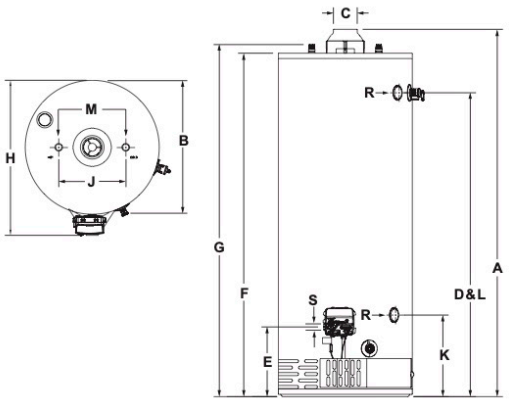
Model Number	Nominal Gal. Capacity U.S. Gal.	Nominal Gal. Capacity Imp. Gal.	DOE Rated Storage Volume (Gal.)	Input BTU/Hr.	First Hour Rating (Gal.)	Uniform Energy Factor	Recovery at 90°F Rise* U.S. GPH	Recovery at 90°F Rise* Imp. GPH
URG250H6N	48	40	46	55,000	110	0.64	59	49
URG275H6N	75	62	72	76,000	135	0.59	82	68
URG2100H6N	100	83	95	80,000	157	0.57	85	71

Model Number	Nominal Liter Capacity	DOE Rated Storage Volume (Liters)	Input kW	First Hour Rating (Liters)	Uniform Energy Factor	Recovery at 50°C Rise* Liters/ Hour
URG250H6N	182	174	16.1	417	0.64	223
URG275H6N	284	273	22.3	512	0.59	310
URG2100H6N	379	360	23.4	595	0.57	322

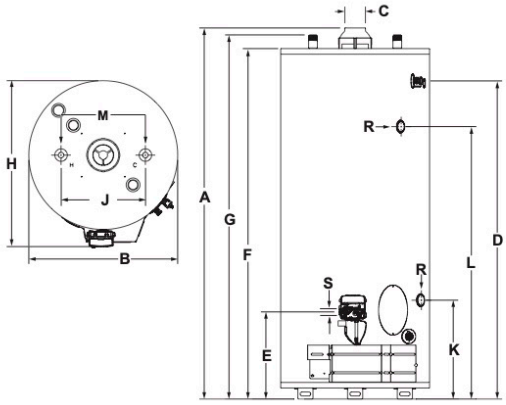
Model Number	A Floor to Flue Conn. in.	B Jacket Dia. in.	C Vent Size in.	D Floor to T&P Conn. in.	E Floor to Gas Conn. in.	F Floor to Top of Heater in.	G Floor to Water Conn. in.	H Depth in.	J C/L of Water Conn. in.	K Floor to Space Heating Inlet in.	L Floor to Space Heating Outlet in.	M Water Conn. NPT in.	R Space Heating Conn. Size in.	S Gas Conn. Size in.	Approx. Shipping Weight lbs.
URG250H6N	60 5/8	22	4	49 7/8	11 7/16	56 3/4	58 1/16	25 3/8	11	13 3/8	49 7/8	3/4	3/4	1/2	194
URG275H6N	64 1/4	26	4	53 3/8	15 1/8	60 5/16	61 3/4	29 3/8	11	16 11/16	53 3/8	1	3/4	1/2	286
URG2100H6N	69 3/8	28 1/4	4	60 3/8	16 1/2	66 1/2	68 5/8	31 3/4	16	18 3/4	51 11/16	1 1/4	3/4	1/2	416

Model Number	A Floor to Flue Conn. mm.	B Jacket Dia. mm.	C Vent Size mm.	D Floor to T&P Conn. mm.	E Floor to Gas Conn. mm.	F Floor to Top of Heater mm.	G Floor to Water Conn. mm.	H Depth mm.	J C/L of Water Conn. mm.	K Floor to Space Heating Inlet mm.	L Floor to Space Heating Outlet mm.	M Water Conn. NPT mm.	R Space Heating Conn. Size mm.	S Gas Conn. Size mm.	Approx. Shipping Weight kg.
URG250H6N	1540	559	102	1267	291	1441	1475	645	279	340	1267	19	19	13	88
URG275H6N	1638	660	102	1356	384	1532	1568	746	279	424	1356	25	19	13	130
URG2100H6N	1762	718	102	1534	419	1689	1743	806	406	476	1313	32	19	13	189

Available in Natural Gas only.
For 10 year models, change suffix from "6" to "10".
* Based on manufacturer's rated recovery efficiency.
Uniform Energy Factor and First Hour Rating is based on the latest AHRI directory listings.



Models URG250H6N & URG275H6N



Model URG2100H6N

General:

Meets NAECA or EPACT Requirements, as applicable.

All gas water heaters are certified at 300 PSI test pressure (2068 kPa) and 150 PSI working pressure (1034 kPa). All Gas Connections are 1/2" (13mm).

All models design-certified by CSA International (formerly AGA/CGA), to meet ANSI standard Z21.10.3 (Z21.10.1 for 48-gallon) and peak performance rated.

Dimensions and specifications subject to change without notice in accordance with our policy of continuous product improvement.

Suitable for Water (Potable) Heating and Space Heating. Toxic chemicals, such as those used for boiler treatment, shall NEVER be introduced into this system. This unit may NEVER be connected to any existing heating system or component(s) previously used with a non-potable water heating appliance.

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BRADFORD WHITE WATER HEATERS
Ambler, PA

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Built to be the Best™

1114-B-0319

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D)

SAMSUNG

SUBMITTAL AR12KSFPDWQXCV / AR12KSFPDWQNCV

Samsung "Quantum", wall mounted evaporator, split system

Job Name _____ Location _____

Purchaser _____ Engineer _____

Submitted to _____ Reference ☐ Approval ☐ Construction ☐

Unit Designation _____ Schedule # _____

Specifications

Model	System Model Number		AR12KSFPDWQ
	Indoor Unit Model Number		AR12KSFPDWQNCV
	Outdoor Unit Model Number		AR12KSFPDWQXCV
Performance	Nominal Capacity*	Cooling / Heating (Btu/h)	12,000 / 13,600
	Capacity Range	Cooling (Btu/h)	3,000 - 13,500
		Heating (Btu/h)	4,000 - 14,500
	SEER / EER		17.00 / 10.50
	COP		3.26
	HSPF		8.50
	AHRI Reference Number		9035288
Power	Voltage	ø / V / Hz	1 / 208-230 / 60
	Working Voltage Range (VAC)		176 - 254
	Operating Current (Min./Std./Max.)	Cooling (A)	1.3 / 5.2 / 6.0
		Heating (A)	1.6 / 5.4 / 5.8
	Max. Breaker	Amps	15
	Min. Circuit Ampacity (A)		10.5
Dimensions	W X H X D (in.)	Indoor Unit	32 1/4 X 11 1/4 X 8 7/16
		Outdoor Unit	31 1/8 X 21 9/16 X 11 1/4
	Weight (lbs.)	Indoor Unit	18.08
		Outdoor Unit	62.8
	Condensate Connection		11/16" OD
Sound Pressure Level	Indoor Unit (dB)	Low / High	20 / 41
	Outdoor Unit (dB)	High	46
Operating Temperatures °F(°C)	Outdoor	Cooling	14 ~ 115°F(-10 ~ 46°C)
		Heating	5 ~ 75°F(-15 ~ 24°C)
	Indoor	Cooling	61 ~ 90°F(16 ~ 32°C)
		Heating	T ≤ 80°F(27°C)
Pipe Connections	Indoor & Outdoor	High side (flare)	1/4"
		Low side (flare)	3/8"
	Maximum / Minimum Line Set Length (ft.)		50 / 10
	Maximum Vertical Separation (ft.)		26
Refrigerant	Type		R410A
	Control Method		Electronic Expansion Valve
	Factory Charge	oz.	31.7
	Charged for		25 feet
	Additional Refrigerant		0.16 oz./ft. over 25 ft.
Compressor	Type		BLDC Rotary
	RLA	A	7.0
Evaporator Fan	Type		BLDC motor with cross-flow fan (1)
	Air Volume	CFM (L / M / H / T)	300 / 330 / 360 / 390
	Consumption	Watts	17
	FLA	Amps	0.07
Condenser Fan	Motor		BLDC motor with axial fan (1)
	Output	Watts	39
	FLA	Amps	0.17
	Air Volume	CFM (max.)	1,400
Optional Accessories	Wireless controller holder		☐ DB61-06087A
	Condensate pump	Aspen Mini Orange	☐ ASP-MO-UNIV 110-250
		Blue Diamond	☐ BD-BLUE-230
	Wired controller	Standard	☐ AR-WRS02 [1]
		Premium (w/scheduling)	☐ AR-WRP2 [2]
	Wired controller sub-PCB		☐ DB93-11412A
	Wired controller sub-PCB harness		☐ DB93-11405A
	External contract control interface module (requires sub-PCB and sub-PCB harness)		☐ MIM-B14
	Wall bracket (for outdoor unit)		☐ CKN-250
	Line sets - insulated and flared, interconnect cables included		☐ 25' - ILS2506
			☐ 50' - ILS5006
	Wind Baffle / Guard	Front	☐ WBF-3M
		Back	☐ WBB-5M
Safety	Certifications		ETL (UL 1995)
	Devices		PCB fuses, indoor unit terminal block thermal fuse, current transformer, over-voltage protection, crankcase heating, temperature limit protection logic, compressor overload sensing
Warranty	7 Years compressor, 5 years parts, 90 day limited labor (registration required)		

* Certified in accordance with the AHRI Unitary Small Air-Source Heat Pumps (USHP) Certification Program which is based on the latest edition of AHRI Standard 210/240.

[1] AR-WRS02 includes MWR-WH00U wired controller, sub-PCB (DB93-11412A), and sub-PCB harness (DB93-11405A)

[2] AR-WRP2 includes MWR-WE13U wired controller, sub-PCB (DB93-11412A), and sub-PCB harness (DB93-11405A)

Samsung HVAC maintains a policy of ongoing development, specifications are subject to change without notice. Refer to www.AHRIdirectory.org for current reference numbers.

(actual equipment appearance may vary)

General Information
- Outdoor unit shall provide 208/230V power to indoor unit via 14 AWG X 3 interconnect power cable
- Electro-static, washable, main filter as standard

Construction
- Indoor unit chassis shall be UL94 V0 with a galvanized steel mounting bracket
- The outdoor unit shall be galvanized steel with a baked on powder coated finish for durability

Heat Exchanger
- The heat exchangers shall be mechanically bonded fin to copper tube

Refrigerant System
- The compressor shall be hermetically sealed, inverter controlled, BLDC Rotary
- Refrigerant flow shall be controlled by electronic expansion valve at outdoor unit

Indoor Fan
- The indoor fan shall be a single, antibacterial cross-flow type
- Three fan speed settings and auto setting
- Automatic (motorized) vertical swing louver (up/down)

Controls
- Control signal shall be DDC type signal
- Interconnect control wiring shall be 16 AWG X 2 shielded wire between outdoor and indoor units
- The indoor unit shall ship with a wireless controller and batteries as standard
- Optional wired control options available

Convenience
- Auto restart
- LED status indicator lights on front of the indoor unit to display unit operation and error status
- "Fast Comfort" mode to quickly reach set temperature
- Auto changeover
- 24 hour, single event timer
- Good sleep mode
- Quiet mode
- Dry mode
- Single event, ON/OFF timer
- Single User Mode to reduce energy consumption during low demand operation
- Air filter cleaning can be done easily without opening the indoor unit
- Beep ON/OFF with included wireless controller

SHA-RAC-03072019

www.SamsungHVAC.com

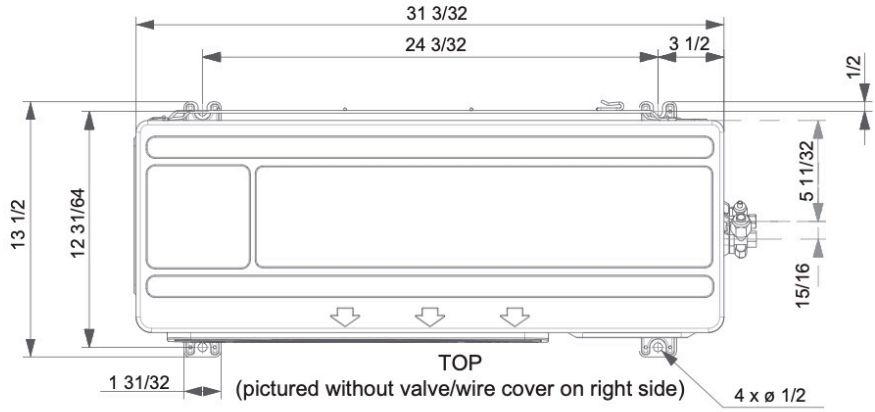
SAMSUNG

SUBMITTAL AR12KSFPDWQXCV / AR12KSFPDWQNCV

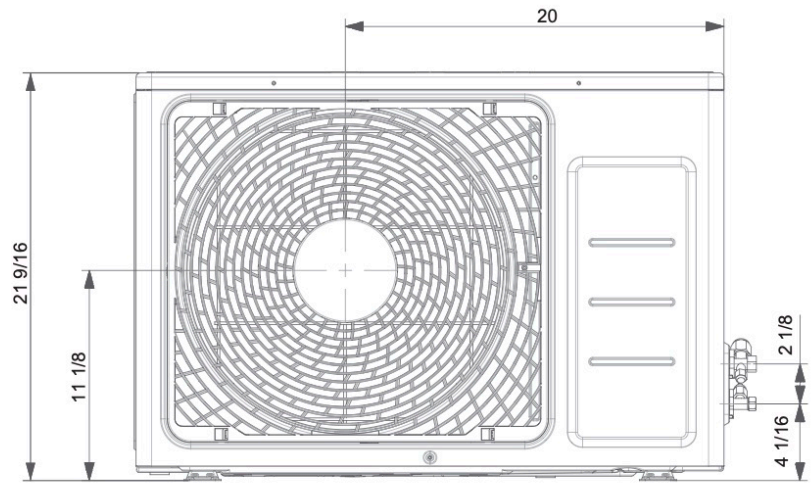
Samsung "Quantum", wall mounted evaporator, split system

Outdoor unit dimensional drawing

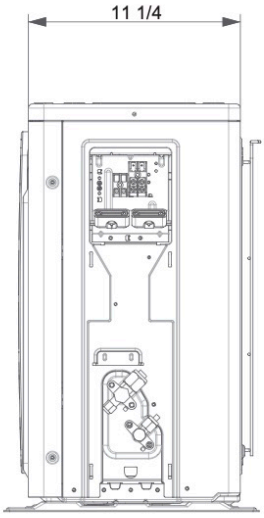
Unit: inches



TOP
(pictured without valve/wire cover on right side)



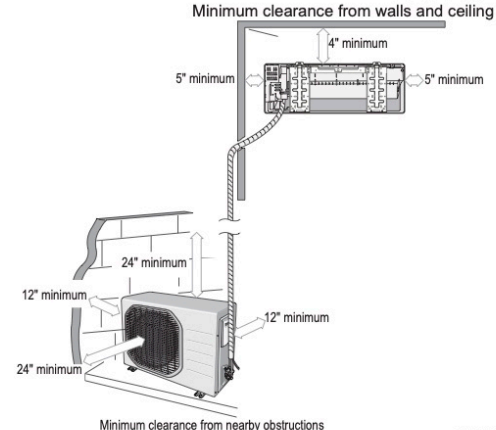
FRONT
(pictured without valve/wire cover on right side)



RIGHT
(pictured without valve/wire cover)

For reference only. Always refer to installation manual for complete details.

Minimum clearance from walls and ceiling



Minimum clearance from nearby obstructions
(See installation manual for full details. Be aware of national, state, and local codes)

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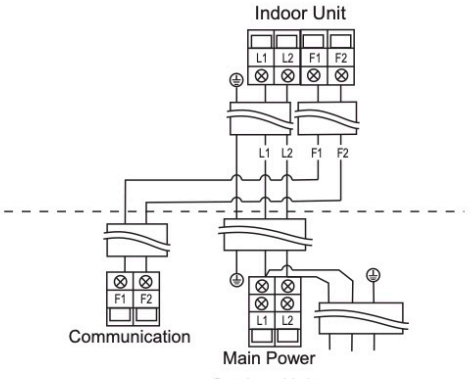
Basic power and communication wiring between indoor and outdoor units



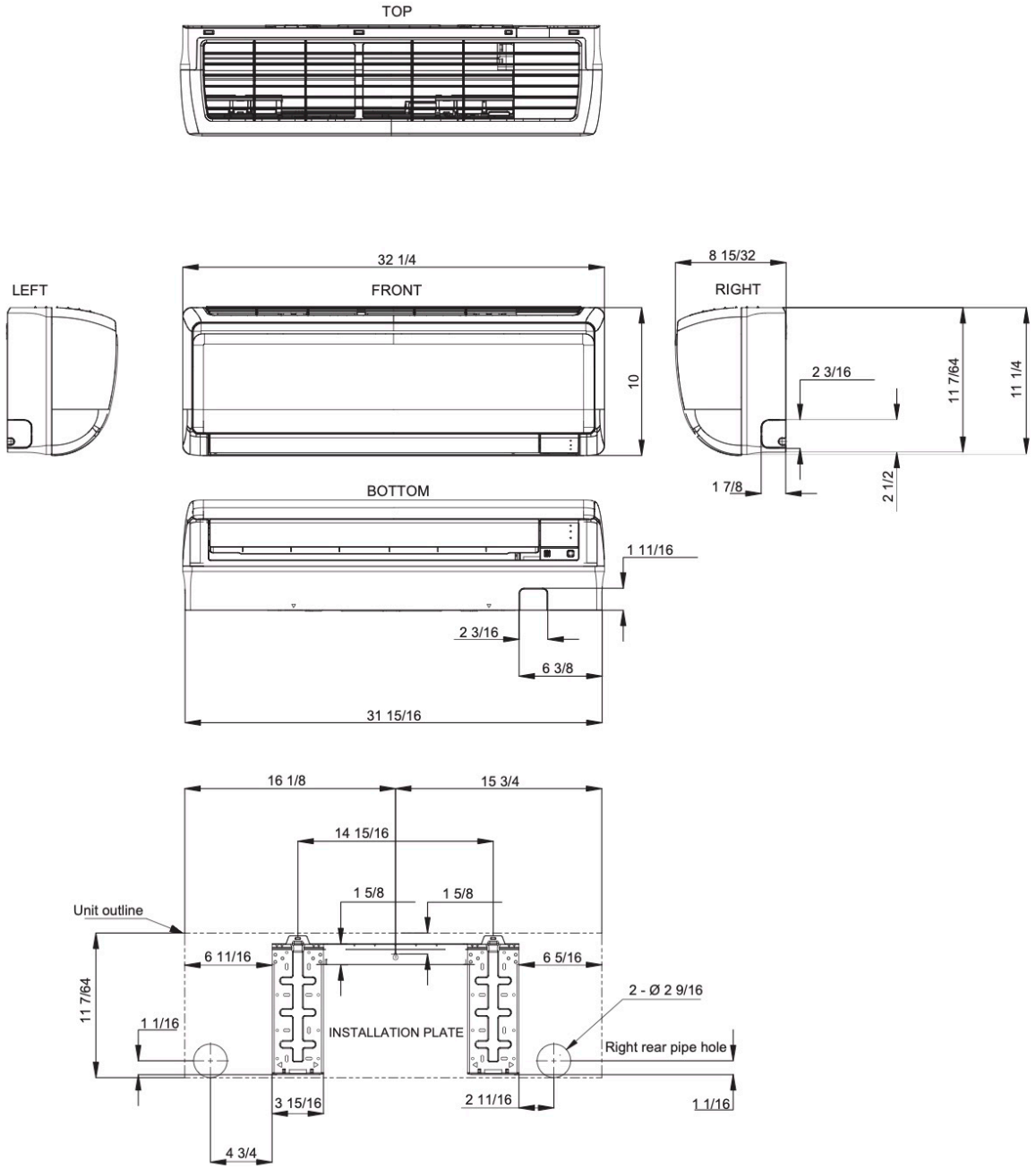
SAMSUNG

SUBMITTAL AR12KSFPDWQXCV / AR12KSFPDWQNCV

Samsung "Quantum", wall mounted evaporator, split system

Indoor unit dimensional drawing

Unit: inches



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SAMSUNG

SUBMITTAL AJ024JCJ3CH/AA

Samsung FJM, 3 Port Condensing Unit

Job Name _____ Location _____

Purchaser _____ Engineer _____

Submitted to _____ Reference ☐ Approval ☐ Construction ☐

Unit Designation _____ Schedule # _____

Performance*	Capacity (standard / max.)	Cooling (Btu/h)	22,000 / 22,000
		Heating (Btu/h)	25,000 / 29,200
	Minimum Cooling Capacity (Btu/h)		7,500
	Minimum Heating Capacity (Btu/h)		4,300
	Maximum Indoor Unit Connection Ratio		135%
	SEER (Ducted / Mixed / Non-ducted)		16.0 / 17.0 / 18.0
	EER (Ducted / Mixed / Non-ducted)		10.1 / 11.1 / 12.1
	HSPF (Ducted / Mixed / Non-ducted)		8.7 / 8.85 / 9.0
Power	Voltage	(ø/V/Hz)	1/208-230V/60Hz
	Rated Current (amps)	Cooling (low / std. / max.)	2.6 / 8.7 / 8.7
		Heating (low / std. / max.)	1.9 / 8.5 / 13.6
	Max. Breaker	Amps	25
	Minimum Circuit Ampacity (A)		16.9
Dimensions	W X H X D	Inches	34 5/8 x 31 7/16 x 14 5/16
	Weight	lbs.	143
Noise Level	Outdoor Unit	dB (A)	49
Operating Temperatures	Cooling		23 - 115°F (-5 - 46.1°C)
	Heating		5 - 75°F (-15 - 23.8°C)
Pipe Connections	High Side		1/4" X 3
	Low Side (suction)		3/8" X 2 + 1/2" X 1
	Maximum Individual Line Set Length		82 ft
	Maximum Line Set Length (total)		230 ft
	Maximum Vertical Separation	Outdoor to Indoor	49 ft
		Highest to lowest indoor	25 ft
	Included Pipe Adaptors		1 - 1/2" X 3/8"
Condenser Fan	Motor		BLDC With Axial Type Fan (1)
	Output	Watts / FLA	165 / 0.65
		CFM	1,468
Compressor	Type		DC, Inverter Driven, Twin BLDC Rotary
	RLA	Amps	13
Heat Exchanger	Type		Aluminum Fin - Copper Tube
	Rows		2
Refrigerant	Type		R410A
	Control Method		Electronic Expansion Valve
	Factory Charge		98.8 oz
	Charged for		131 ft
	Additional Refrigerant		0.11 oz/ft over 131 ft
Accessories	Wall Bracket		☐ CKN-250
	Wind Baffle	Front	☐ WBF-4M
		Back	☐ WBB-1M
	Central Control Interface Module	DVM S Controls (NASA)	☐ MIM-N01
		DVM Plus Controls	☐ MIM-B13D
	Wi-Fi Adapter for Remote Control		☐ MIM-H03U
Certifications	Safety		ETL (UL 1995)
	AHRI Certification Number	Non-Ducted	7915888
		Ducted	7915889
Warranty	10 Years compressor, 10 year parts, 1 year limited labor (registration required)		

* Certified in accordance with the AHRI Unitary Small Air-Source Heat Pumps (USHP) Certification Program which is based on the latest edition of AHRI Standard 210/240.

Samsung HVAC maintains a policy of ongoing development, specifications are subject to change without notice.
Refer to www.AHRIdirectory.org for current reference numbers.

- Low ambient control built in
- The outdoor unit shall supply power to indoor unit(s) via 14 AWG X 3 power wire
- Soft-start to reduce current demand during compressor start
- Auto-restart after power loss
- Available maximum current setting option to reduce maximum operating current.

Construction
The outdoor unit shall be galvanized steel with a baked on powder coated finish for durability

Heat Exchanger
The heat exchanger shall be mechanically bonded fin to copper tube

Controls
Control signal shall be a DDC type signal

Interconnect control wire between outdoor and indoor units shall be 16AWG X 2 shielded

Controls shall integrate with a BMS system

The system shall integrate with the Samsung Controls Solution

Refrigerant System
The refrigerant shall be R410A

The compressor shall be hermetically sealed, inverter controlled, Twin BLDC Rotary

Refrigerant flow shall be controlled by 3 separate electronic expansion valves at outdoor unit

Compatibility
Will only operate with Samsung evaporator model numbers: AJ009JNLDCH/AA, AJ012JNLDCH/AA, AJ018JNLDCH/AA, AJ009JNNDCH/AA, AJ012JNNDCH/AA, AJ018JNNDCH/AA, AJ009NBNDCH/AA, AJ012NBNDCH/AA, AJ018NBNDCH/AA, AJ007JNADCH/AA, AJ009JNADCH/AA, AJ012JNADCH/AA, AJ018JNADCH/AA.

SHA-FJM-07232018

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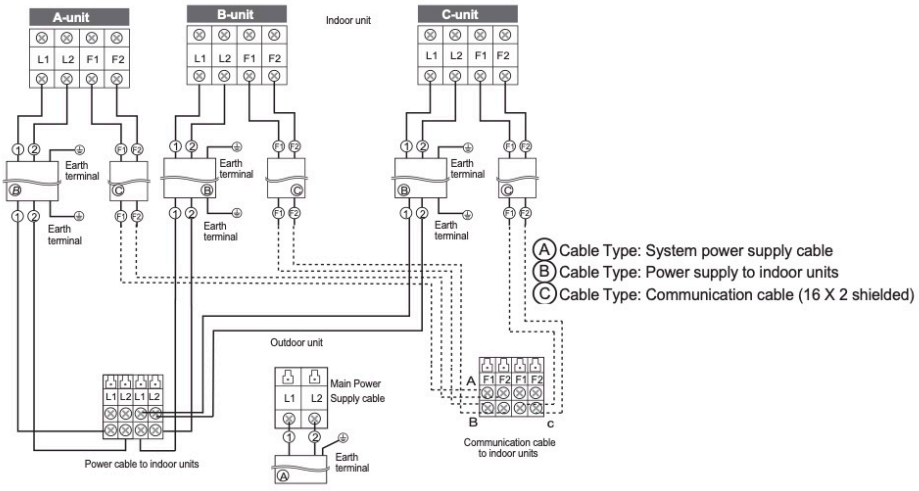
Indoor Unit Connection Options

	Indoor Unit		
	A	B	C
2 Indoor Units	AJ007***DCH/AA	AJ007***DCH/AA	
	AJ007***DCH/AA	AJ009***DCH/AA	
	AJ007***DCH/AA	AJ012***DCH/AA	
	AJ007***DCH/AA	AJ018***DCH/AA	
	AJ009***DCH/AA	AJ009***DCH/AA	
	AJ009***DCH/AA	AJ012***DCH/AA	
	AJ009***DCH/AA	AJ018***DCH/AA	
	AJ012***DCH/AA	AJ012***DCH/AA	
	AJ012***DCH/AA	AJ018***DCH/AA	
3 Indoor Units	AJ007***DCH/AA	AJ007***DCH/AA	AJ007***DCH/AA
	AJ007***DCH/AA	AJ007***DCH/AA	AJ009***DCH/AA
	AJ007***DCH/AA	AJ007***DCH/AA	AJ012***DCH/AA
	AJ007***DCH/AA	AJ009***DCH/AA	AJ009***DCH/AA
	AJ007***DCH/AA	AJ009***DCH/AA	AJ012***DCH/AA
	AJ009***DCH/AA	AJ009***DCH/AA	AJ009***DCH/AA
	AJ009***DCH/AA	AJ009***DCH/AA	AJ012***DCH/AA

Basic Wire Connection Diagram



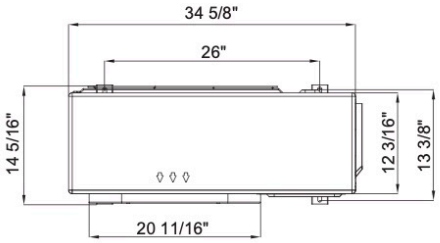
This simple wiring diagram is for reference only. Please refer to installation manuals for full details and requirements.

SAMSUNG

SUBMITTAL AJ024JCJ3CH/AA

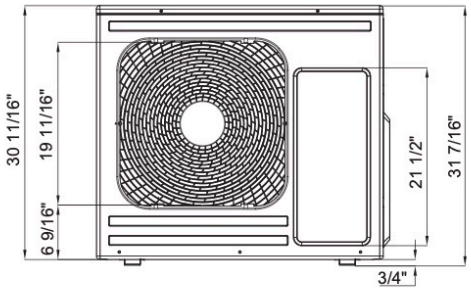
Samsung FJM, 3 Port Condensing Unit

Dimensional drawing

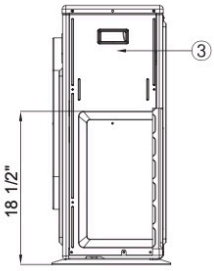


TOP

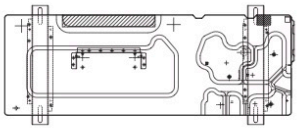
LEFT



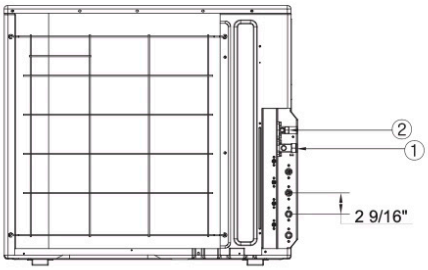
FRONT



RIGHT



BOTTOM



BACK

No.	Description
1	Suction service valve
2	Liquid service valve
3	Wire and pipe service cover

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E)

220100 - PLUMBING

PART 1 GENERAL

1.1 NOTE

A. See section 200100

1.2 SERVICES:

A. Each service (storm, waste, vent, cold water and hot water) shall be complete and extended and connected up with all using fixtures and installed under all divisions of work on this project.

1.3 INSPECTION AND TESTS

A. All tests shall comply with the requirements of the governing authority or serving utility as the case may be. The Owner's representative and the Plumbing Inspector shall be notified in advance of all tests and shall be present at such tests. No work shall be covered up until it is inspected and approved.

B. Drainage System - The new drainage and venting system shall be tested to conform with International Building Code or as directed by the Plumbing Inspector.

PART 2 MATERIAL

2.1 PIPING MATERIALS:

A. All materials shall be new and for intended use and be free from defects. Pipe and fittings shall be of design to withstand 125 lbs. S.W.P.
   1. Sanitary and Storm Sewers (Underground & Interior) - Underground sanitary and storm sewers shall be Carlon or approved equal Schedule 40 PVC (solid core) sewer pipe and drain fittings, solvent welded joints.
   2. Sanitary, Vent, and Storm Sewers - (In return air plenum and above ceiling office area) –
      a. No-hub cast iron standard weight. Joints shall be made with "Clamp-All" or "Husky" stainless steel coupling with neoprene gasket.
      b. Schedule 40 PVC (solid core) drainage pipe and fittings, joints to be solvent welded. Pipe shall be wrapped with fire proofing material.
   3. Soil, Waste and Vent Piping - (Above Ground Interior, Below Return Air Plenum) - Schedule 40 PVC (solid core) drainage pipe and fittings, joints to be solvent welded. Install expansion joint in vertical stack prior to stack penetrating roof.

4. Water Piping (Inside Building and apartments) – All hot and cold water piping shall be:
    a. Type “L” hard copper pipe with wrought copper sweat solder type fittings. Soldered joints shall be made using “Stay-Safe 40” lead free solder (J.W. Harris Co., Cincinnati, Ohio) or other lead free solder as approved by the State of Ohio. Copper press fitting may be used as an option
5. Water Piping (Inside apartments - Optional) –Hot and Cold water piping shall be:
    a. Domestic Water piping using PEX or other Cross-Linked Polyethylene Piping type “A”- Shall be installed to each plumbing fixture as a single length of continuous polyethylene cross-linked pipe (no joints are allowed other than ends connection)
6. Gas Piping - Underground gas service piping shall be plastic pipe as approved by the serving utility to a minimum of 3 feet from the building wall as required by the serving utility.
7. Gas Piping - Above ground gas piping shall be:
    a. Standard weight black steel schedule 40 with malleable iron fittings for screwed piping and welding fittings for welded piping.
    b. Corrugated Stainless Steel Tubing: ANSI LC 1.
8. Underground gas service piping shall be plastic pipe as approved by the serving utility to a minimum of 3 feet from the building wall as required by the serving utility.
9. Transition Riser - Transition riser (plastic to steel) as manufactured by Perfection Corporation, Madison Ohio shall be used to change from plastic service line underground to steel pipe above ground gas piping.
10. Water Hammer Arrestors
    a. Contractor shall install air chambers at top of pipe drops to quick closing valves and any system that requires time laps to fill up.
    b. Contractor shall furnish and install air chambers at each hot and cold water fixture or group of fixtures connection. Chambers shall be 18” high and of the same diameter as the fixture connection, but not less than ½”.
11. Insulating Couplings - V-line insulating coupling as manufactured by Victaulic or Perfection Corporation or approved equal.
12. Vents and Flashings - All vents shall terminate 24” above roof. All vents and soil extension shall be flashed with approved aluminum flashing, neoprene self-sealing.
13. Escutcheons - All pipe passing through walls, floors or ceilings in finished rooms shall be fitted with steel, brass or plastic escutcheons..
14. Cleanouts - A cleanout shall be installed at the base of each soil and waste stack, downspout and at not more than 50 ft. intervals on horizontal runs and as required by Code. Cleanouts shall be the same size as the pipe they serve, except they need not be larger than 4”.
15. Hangers - All horizontal pipe shall be supported on adjustable split steel ring or clevis hangers and threaded rods spaced not over 10’-0” o.c. for pipe 1-1/2” and larger and 6’-0” o.c. for pipe 1-1/4” and smaller. Chain or band iron hangers and trapeze hangers will be acceptable. Pipe hangers for insulated piping systems shall be sized for the gross outside dimension of the pipe and insulation. See insulation specifications for insulation requirements.

2.2 VALVES:

A. Furnish and install as shown on drawings valves and as required for proper operation of various parts of work. Valves shall be as manufactured by Powell, Nibco, Apollo, or Milwaukee.

B. Drain valves with hose connecting ends and protective caps shall be installed at low points on all lines carrying liquids.

C. Compression type valves shall not be used for drain valves.

D. Provide shut-off valves at all branch connections to main, at all fixture groupings, each piece of apparatus, and in mains to sectionalize the system.

E. Schedule of Valves:
   1. Ball Valve (Stainless Steel Ball)
      a. Sizes: 2" and under
      b. Nibco No.: S-580-66 (Soldered), T-580-66 (Threaded)
      c. Body: Bronze
      d. Ball: Ends: Soldered or threaded
      e. Pressure: 150 WSP

   2. Check Valve:
      a. Sizes: 2" and under
      b. Nibco No.: 413
      c. Body: Bronze
      d. Ends: Threaded
      e. Pressure: 125 WSP

F. Gas Valves - (Above Ground and Inside the Building) - Milwaukee "Butterball" butterfly valve, AGA approved, or equal.

G. Interior Single Hose Valves - Shall be Chicago Faucet No. 952 or equal by Speakman or Royal Brass, polished chrome plate with vacuum breaker.

H. Exterior Wall Hydrants - Shall be Smith No. 5609 anti-freeze type with vacuum breaker, 3/4" size for required wall thickness. Equal by Zurn, Woodford or Wade shall be acceptable.

I. Backflow Preventer - Watts regulator, or approved equal, Model 909S-QT reduced pressure backflow preventer with bronze strainer and ball valves. Backflow preventer shall be the same size as the incoming water line.

J. Trap Primer - J.R. Smith, or approved equal, series 2699, 1/2" bronze trap primer valve with vacuum breaker.

K. Pressure Reducing Station - Wilkens #500PRV with a 25 to 75 PSI range.

L. Water hammer arrester: Sioux Chief, or approved equal, hydra-rester, shall be pre-charged and permanently sealed at the factory and shall have a male threaded nipple

for connection to the water system. Water hammer arresters are noted WAHA-X. Where the 'X' designates the P.D.I. symbol described in P.D.I. standard manual WH-201.

M. Tempering valves: Install at all public hand washing Lavs and sinks a tempering valve that meets ASSE 1017 similar to Powers Thermostatic Mixing Valve LM495M

2.3 DRAINS:

A. Floor drains
   1. General floor drains: J.R. Smith, or approved equal, series 2000 of model and sizes as shown on the plans. Furnish with trap primer connection and outlet as required by piping material. Provide appropriate top as scheduled below:
      a. Round Top - resilient tile flooring.
      b. Square Top - rectangular pattern tile floors.
      c. Floor drains occurring in waterproof floors shall be furnished with clamping devices or flanged top as required by the installation.
      d. As required by the architect.
   2. Equipment rooms floor sinks: J.R. Smith, series 3000 of model and sizes as shown on the plans. Furnish with trap primer connection, caulked outlet and round top.

2.4 CLEANOUTS:

A. Furnish access doors for wall or ceilings concealed cleanouts.

B. Floor Clean-out: J.R. Smith, or approved equal, with taper thread, bronze plug, scoriated cover and outlet as required by the piping material for the following applications:
   1. Exterior - 4220, extra heavy duty with a round cast iron top.
   2. Finished concrete floor - 4020 with a round, scoriated nickel bronze top.
   3. Resilient tile floor - 4140 with a round nickel bronze **or plastic** top. Furnish with scoriated or tile recess as required by architect.
   4. Rectangular pattern tile floors - 4040 with a square nickel bronze **or plastic** top. Furnish with scoriated or tile recess as required by architect.
   5. Cleanouts occurring in waterproof floors shall be furnished with clamping devices.

C. Wall Clean-Outs - J.R. Smith, or approved equal, series 4422-Y with taper thread and bronze plug, stainless steel **or plastic** cover and appropriate length screw.

2.5 INSULATION:

A. Furnish and install the following insulation in full accordance with manufacturer's recommendations. All piping listed below with required insulation thickness shall be as listed below.

B. Clean and dry surfaces prior to insulation.

C. Extend insulation without interruption through walls, floors, hangers and similar penetrations.

D. Material:
   1. Fiberglass ASJ/SSL-11 pipe insulation with factory applied jacket of a vinyl coated and embossed vapor barrier laminate. All jacket laps to be sealed with factory applied self-sealing lap (SSL). All butt joints to be sealed with factory provided ASJ butt strips. Insulate fittings with molded or segmental insulation, a layer of mastic, a layer of glass cloth fitting tape, and a finish layer of mastic completely covering the fitting tape. Fitting mastic on hot pipe to be OCF Type "H", on cold to be OCT Type "C". All fittings, valve bodies, valve bonnets and unions on plumbing piping shall be insulated. In lieu of the standard method described for insulating the fittings the insulation Contractor has the option of using Zeston's One Piece Premolded Insulated Fittings, wherever possible, per manufacturer's recommendation. Pipe insulation shall not be stapled.
   2. Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular form: ASTM C534; Type I, Tubular form. Air dried, contact adhesive, compatible with insulation. Seal all joints with #520 adhesive

E. Schedule:
   1. Plumbing hot and cold water piping mains:
      a. 1" cellular foam
   2. Plumbing hot and cold water piping runouts:
      a. 3/4" Cellular Foam

F. All insulation shall be applied in an approved manner, the workmanship shall be first class and all joints shall be made tight. Insulation shall be Owens-Corning, Armstrong, Certain-Teed/Saint Gobain, Knauf or Schuller.

2.6 WATER HEATERS (GAS FIRES HIGH EFFICIENCY):

A. The water heater shall be a, A.O. Smith Cyclone MXI #BTH-150 for 4 & 6 plex building and A.O.Smith Cyclone XI BTXL-100 for laundry mech rooms; Bradford White or Rheem. The unit shall be a factory assembled and tested packaged water heater with a total thermal efficiency of 98%.

B. The burner section shall have a sealed submerged combustion chamber, for direct venting using PVC or CPVC with a low NO_x operation that exceeds air quality requirements of all code jurisdictions.
   1. The flue design shall provide for multiple passes to assure thermal efficiency.
   2. The burner shall have an electronic ignition system.
   3. Provide concentric vent kit for each water heater

C. Storage tank shall be heavy strength steel tested to twice the rated capacity of 150 psi. The tank shall have a heavy gauge steel jacket with a minimum R16 foam insulation. The tank shall be glass lined and provided with tank protecting anodes. The tank shall be provided with ASME temperature and pressure relief valve and brass drain valves.

D. Accessories: Brass water connections and dip-tube, drain valve, magnesium anode, and ASME temperature and pressure relief valve.

E. Amtrol Expansion tank**.**

F. Provide drain pan for all hot water tanks. Units shall be mounted on 4” blocks inside pan. Pan shall be drained to floor drain

2.7 HOT WATER EXPANSION TANK

A. Furnish and install in cold water line supplying the water heaters as indicated on the drawings an Armtrol “Therm-x-trol” thermal expansion absorber Model Number as indicated on drawings.

B. Other acceptable manufacturers are: Zurn or Wessel

2.8 PLUMBING FIXTURES:

A. Plumbing fixtures, trim and other equipment shall be protected against damage or injury. All fixtures and equipment damaged by any cause and any trim with marred or scratched finish shall be replaced at no additional cost to the Owner. The fixture protection shall be removed at the completion of the work or for final inspection.

B. Install each fixture with trap, easily removable for servicing and cleaning.

C. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.

D. Install and secure fixtures in place with wall supports, wall carriers and bolts.

E. See drawings for fixture schedule.

PART 3 EXECUTION

3.1 EXCAVATION AND BACKFILL:

A. Contractor shall do all excavating and backfilling necessary for the installation of his work.
1. All trenches shall be dug to exact grade and depth with only sufficient dirt removed to providing working space. Trenches dug below the required depth shall be refilled to proper depth with Aggregate #57. Trenches shall be shored for sheet pile, if necessary, to prevent caving and the work of other Contractors shall not be endangered. This Subcontractor will be held solely responsible for damage caused by his work.
2. All excavations inside the building, under walks and drive shall be backfilled with premium backfill slag or limestone screening thoroughly tamped and flooded.

3.2 PIPE INSTALLATION:

A. All piping shall be concealed except where called for otherwise. Piping shall be installed with proper provision for expansion and contraction and so as not to sag in use.

3.3 FIRESTOPPING

A. Provide firestopping at penetrations required for the passage of a duct, cable, cable tray, conduit, piping, electrical busways and raceways through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies),and vertical service shaft walls and partitions.

B. Quality Assurance
   1. Firestop system installation must meet requirements of ASTM E-814 or UL1479 tested assemblies that provide a fire rating equal to that of the construction being penetrated.
   2. Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.
   3. Firestop system does not re-establish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult structural engineer prior to penetrating any load bearing assembly.
   4. For those firestop applications that exist for which no UL system is available through any manufacturer, a manufacturer's engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council (September 7, 1994).
   5. Engage an experienced installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary experience, staff and training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell its firestopping products to the contractor or to the installer engaged by the contractor does not in itself confer qualifications on the buyer.

C. Products
   1. Use only firestop products that have been ASTM E-814 or UL 1479 tested and approved for specific fire-rated construction assembly type, penetrating item type, annular space requirements and fire-rating involved for each separate instance.
   2. Acceptable Manufacturers: Hilti, 3M, Metacaulk, Nelson

D. Contractor's Commissioning
   1. Verify that each individual water heater unit for complete installation but not limited to piping, clean up and start up.
   2. Provide such completion process and testing in writing for each unit.

END OF SECTION 220100

SECTION 230100 – HVAC

PART 4 GENERAL

4.1 NOTE

A. See section 200100

PART 5 MATERIAL

5.1 EQUIPMENT PIPE CURBS, PIPE CURBS, DUCT CURBS

A. Manufacturers: Pate Model ES-5, Thy, Roof Products & Systems or Uni-Curb.

B. Equipment Curbs: Welded 18 gage galvanized steel shell and base, mitered cant to match roof insulation, and factory installed wood nailer sized to suit building structural systems and equipment selected.

C. Pipe Curbs: Welded 18 gage galvanized steel shell and base, mitered cant to match roof insulation. Units shall be with base plate insulated, top nailer, cover, and graduated step neoprene boots with stainless steel band clamps.

D. Duct curbs are of similar construction to pipe curbs.

5.2 PIPING MATERIALS

A. Hot water supply and return piping shall be Type 'L' hard copper. Fittings for copper pipe shall be wrought copper solder joint type.

B. Refrigerant - ACR copper - cleaned and deoxidized, capped and sealed when received at job site and until installed.

C. Condensate - PVC

5.3 VALVES

A. Valves in hot water piping size 2" and under shall be Stockham 285 Series ball valves with bronze body, stainless steel balls and screwed ends, 150 lbs. S.W.P. Valves used for shut-off and balancing shall be equipped with memory stop.

5.4 PIPE SUPPORT

A. Hangers - All horizontal pipe shall be supported on adjustable split steel ring or clevis hangers and threaded rods spaced not over 10 ft. o.c. for pipe 1-1/2” and larger and 6 ft o.c. for pipe 1-1/4” and smaller. Chain or band iron hangers and trapeze hangers will be acceptable. Pipe hangers for insulated piping systems shall be sized for the gross outside dimension of the pipe and insulation. See insulation specifications for insulation requirements.

5.5 EXHAUST FANS

A. Fans shall be Greenheck SP- B70 Broan, Panasonic, or Cook with all accessories shown on drawings.

B. Provide wall or roof cap for ceiling fans. Provide Backdraft Damper Gravity actuated, aluminum multiple blade construction, felt edged with nylon bearings.

C. In fire rated ceiling assemblies provide fan with ceiling fire damper.

D. Provide Disconnect Switch Factory wired, non-fusible, in housing for thermal overload protected motor. Provide timer switch for fan On/Off. For Fan/Light combination provide single switch.

E. For residential bathroom exhaust fan provide 2 speed motor for continuous operation at low speed. See schedules.

5.6 ELECTRIC HEATERS

A. Heaters shall be as manufactured by Berko, Q-Mark, Electromode or Markel, with integral disconnect switch, thermostat, wall brackets, back plates and all accessories required for complete installation. Verify power supply with electrical drawings.

B. Verify available power with electrical contractor prior to ordering equipment.

5.7 SHEET METAL WORK

A. All ductwork and fittings shall be fabricated, assembled and installed in accordance with the latest revision of SMACNA HVAC Duct Constructions Standards.

B. All duct sizes on drawings indicate free internal dimensions. Actual sheet metal sizes shall include on allowance for internal duct liner.

C. Ductwork shall be fabricated of prime grade materials free from any imperfections. Galvanized sheet steel shall be G 90 zinc coated and mill phosphatized for painted applications on exposed ductwork in conditioned spaces.

D. Construction:
   1. General supply air, return air, exhaust air, relief air and outside air ductwork within the building shall be 2” SMACNA pressure classification galvanized steel unless noted otherwise on the drawings.
   2. SMACNA pressure classification rectangular or spiral ductwork.
   3. All sheet-metal exposed to weather shall be made of Aluminum.
   4. Install and seal all ductwork in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible. Seal duct connection to HVAC equipment and all supply and return outlets to branches and main duct. Sealant to be Non-hardening, water resistant, fire resistive, compatible with mating materials, UL listed duct sealer. Seal class "B" for all ductwork up to 2" pressure

class, seal class "A" for all ductwork above 2" pressure class. Cloth based duct tape is not acceptable.

E. Elbows or turns in the ductwork shall be fabricated with a center line radius of not less than 1.5 times the duct width or with elbows with integral turning vanes. Transitions and offsets shall be fabricated with a max angular taper of 30 degrees unless space conditions prohibit.

F. Flexible ductwork
   1. Flexible duct shall have a flameproof vinyl sheath with spiral wound spring steel and 1" thick fiberglass insulation (R-5) with a vinyl vapor barrier exterior jacket.
   2. Flexible ductwork installation shall be a maximum of ten (10) feet in length and no more than 1-90 deg. elbow.
   3. Flexible duct is prohibited to have 90 degree elbow of flexible duct. Provide hard duct at all 90 degree elbows.
   4. Flexible duct shall be adequately supported every 5 ft. by straps at least 1" wide to prevent reduction of cross section.
   5. Flexible duct shall be connected to metal collars with plastic lockable straps. Cloth based duct tape connection is not acceptable.

G. Ductwork branches off of mains shall generally be arranged as follows:
   1. Rectangular branches off of rectangular mains shall be with 45 degree shoe entry type top in fittings.
   2. Round branches off of rectangular mains shall be made with conical type top in fittings if the main is 4" or greater in depth than the branch diameter. Otherwise, a 45 degree shoe entry type top in fitting with rectangular dimensions of equivalent cross sectional area to the round branch diameter shall be used immediately followed by a rectangular to round transition.
   3. Round branches off of round mains shall be made with Y-branch, conical top, 45 degree shoe entry top, or tee fittings as indicated on the drawings.
   4. Provide at each branch and split a volume damper for air balancing.

H. Access panels shall be installed for fusible link repair for each fire damper and **as** indicated on the drawings. Access panels shall have extended frames for externally insulated ductwork. Access panels shall be factory insulated for all insulated ductwork applications. Access panels shall be of the cam lock type fitted for air tight closure and shall be rated for the SMACNA pressure classification in which it will be applied.

I. Access doors to mechanical equipment above plaster or dry wall ceilings shall be furnished by contractor to general trades contractor for installation. For type and specification, see Division 8.

J. Fire dampers shall be installed for ductwork penetrations and air openings through all fire rated building assemblies. Dampers shall be UL labeled frame style "B" for rectangular ductwork and openings and frame style "C" for round and flat oval ductwork. Dampers shall be curtain type with interlocking blades outside of the air stream and a 212 degree F fusible link. Damper rating shall be 1-1/2 hour for 1 or 2 hour rated assemblies and 3 hour rated assemblies.

K. Ceiling Radiation Dampers

1. Install where indicated on the drawing Ruskin Model CFD(R) 5 ceiling diffuser radiation shields.
2. Provide complete with 168°F fusible link, thermal mineral wool insulation blanket, 1-1/2 hour rating and UL classified.
3. Other approved manufacturers: Air balance and Greenheck.

L. All exhaust (Dryer, Bathroom, Kitchen) ductwork shall be aluminum solid sheet-metals with 45 degrees bends or 90 deg long radius elbows only. Provide aluminum roof or wall cap.

5.8 AIR DISTRIBUTION

A. All air outlets shall be as manufactured by Lima, Hart & Cooley, Price or Titus and shall be of size shown on the drawings. Each outlet (Linear, square, rectangular or round) shall be furnished with combination equalizing damper and volume control damper in extension collar of outlet. All outlets in finished ceiling shall have off-white baked enamel finish. Outlets in lay-in ceilings shall have nominal panel sizes to fit ceiling grid system.

B. Louvers: - Shall be as manufactured by Ruskin Model ELF-375, Airolite, Construction Specialties or American Warming. Louver shall be 4 inch deep with blades on 45 degree slope, heavy channel frame, birdscreen with 3/4” square mesh, factory prime coat finish color to be selected by Architect. Louver shall be furnished by contractor, to be installed by General Trades Contractor.

5.9 INSULATION

A. Furnish and install the following insulation in full compliance with manufacturer's recommendations:
1. All heating hot water supply and return piping:
    a. Flame retardant Armaflex pipe insulation 1/2" thick. Seal all joints with #520 adhesive. Insulate all valves and fittings to match adjacent piping.
2. All supply ducts:
    a. Insulate with 1-1/2” thick Fiberglas faced duct wrap type ED75 and R-5.1 with flame retardant facing (FRK). Wrap insulation tightly on the duct with all joints butted. Adhere insulation with 4” strips of bonding adhesive at 8” o.c. Tape all joints with 4” wide tape adhered with vapor barrier adhesive.
3. All return air duct and plenums:
    a. 1” internally insulated fiberglass duct liner type aeroflex.
4. Refrigerant suction piping:
    a. Flame retardant Armaflex pipe insulation 1/2" thick. Seal all joints with #520 adhesive. Insulate all valves and fittings to match adjacent piping.
5. Exposed and underground refrigerant piping and controls:
    a. Shall be bundled and covered with PVC split insulation jacket with cemented joints per manufacturer's recommendations.

B. All insulation shall be applied in an approved manner, the workmanship shall be first class and all joints shall be made tight. Insulation shall be Owens-Corning, Armstrong, Certain-Teed/Saint Gobain, Knauf or Manville.

5.10 TEMPERATURE CONTROL:

A. Contractor shall provide all thermostats, relays, control wiring and all accessories required to complete all Temperature Control Work.

B. All wiring shall be done per NEC, State and Local code.

C. Furnish owner with three (3) sets of operating instructions.

D. Exhaust fans that are thermostatically operated shall interlock out side air damper with fan starter. Contractor shall provide line voltage or low voltage dampers operators to be compatible with fan controls.

E. Electric unit heaters and baseboard heaters shall be controlled from integral electric thermostat.

F. Residence and public spaces AC units shall be controlled from 5 day-2 day programmable thermostat furnished with unit.

PART 6 EXECUTION

6.1 GENERAL PIPING

A. Install valves with stems above horizontal position.

B. Install all valves and equipment with unions or flanges to facilitate removal.

C. Provide hose end drain valves at all low points, trapped sections and on equipment side of all branch valves to permit draining of all parts of liquid piping systems.

D. Pipe equipment drip bases to nearest drain where possible or as indicated on the drawings.

E. Locate covered piping a sufficient distance from walls, other pipe, ductwork or other obstacles, to permit application of the full thickness of insulation specified. If necessary use extra fittings and pipe.

F. Arrange and install all pipes, valves, cleanouts, access openings and equipment so as to be accessible for service. Locate equipment to maintain clearances for tube, coil pulling and/or periodic servicing.

G. Do not suspend a pipe from another pipe. Do not support ceiling framing or lighting from piping.

6.2 TESTS AND ADJUSTMENTS:

A. Perform tests and adjustments under Contractor's supervision and report to Architect. During testing period, maintain on job a competent engineer thoroughly familiar with all

phases for as long a period as required to thoroughly adjust all systems and demonstrate to Architect that they are functioning properly.

B. For air handling and air distribution systems, procure services of an independent agency that specializes in testing and balancing of such systems. All work by this agency to be done under direct supervision of a qualified Heating and Ventilating Engineer.

C. Testing Adjusting and Balancing work shall be done in accordance with AABC, NEBB or ASHRAE recommendations.

D. The test and balance agency shall perform tests and make all adjustments as required to balance the HVAC systems to the following criteria:
   1. All fans shall perform “equal to” or “10% in excess of” the design volume.
   2. Minimum Outdoor air requirements shall be within 5% above or below the design volume.
   3. Supply diffusers and registers shall be within 10% above or 5% below the design volume.
   4. Return and exhaust grilles shall be within 5% above or 10% below the design volume.
   5. At the end of testing and balancing submit a report for each air-handling unit.
   6. Contractor shall complete Energy Star commissioning check list for each air Handling unit.

E. Contractor’s Commissioning
   1. Verify that each individual unit for complete installation but not limited to refrigerant piping, ductwork, controls, clean up and start up.
   2. Provide such completion process and testing in writing for each unit.

6.3 FIRE-STOPPING

A. Provide fire-stopping at penetrations required for the passage of a duct, cable, cable tray conduit, piping, electrical busways and raceways through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies) and vertical service shaft walls and partitions.

B. Quality Assurance
   1. Fire-stop system installation must meet requirements of ASTM E-814 or UL1479 tested assemblies that provide a fire rating equal to that of the construction being penetrated.
   2. Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.
   3. Firestop system does not re-establish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult structural engineer prior to penetrating any load bearing assembly.
   4. For those firestop applications that exist for which no UL system is available through any manufacturer, a manufacturer’s engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer

judgment drawings must follow requirements set forth by the International Firestop Council (September 7, 1994).

5. Engage an experienced installer who is certified, licensed, or otherwise qualified by the fire-stopping manufacturer as having the necessary experience, staff and training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell its fire-stopping products to the contractor or to the installer engaged by the contractor does not in itself confer qualifications on the buyer.

C. Products

1. Use only firestop products that have been ASTM E-814 or UL 1479 tested and approved for specific fire-rated construction assembly type, penetrating item type, annular space requirements and fire-rating involved for each separate instance.
2. Acceptable Manufacturers: Hilti, 3M, Metacaulk, Nelson

END OF SECTION 230100