



**JB ENGINEERING AND CODE CONSULTING, P.C.**

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**JULIUS A. BALLANCO, P.E.**  
President

March 27, 2012

**Report Number: 12S0327E1**

**- Engineering Report -**  
Cost Analysis of High-Rise Vent System

**Client:** IPS Corporation  
500 Distribution Parkway  
Collierville, TN 38017

**Purpose:** JB Engineering and Code Consulting, P.C. was requested to prepare a comparative cost analysis of a vent system in a high-rise building. One analysis would be with a vent system not using air admittance valves (AAV) and positive air pressure attenuators (PAPA); the other would be with the vent system using air admittance valves. The high-rise building selected for analysis is a 10 story residential building with 45 units.

**Abstract:** The ICC International Plumbing Code permits many venting systems for protecting the trap seal and maintaining a balance of pressure in the drainage system. The types of venting systems include: individual venting, common venting, wet venting, circuit venting, waste stack venting, and engineered vent systems. The International Plumbing Code also permits the use of air admittance valves. Positive air pressure attenuators are permitted by the International Plumbing Code as a part of an engineered vent system.

When air admittance valves are used, a minimum of one vent must extend to the outdoors for a plumbing drainage system. Individual and branch type air admittance valves are permitted to be used on individual floors as a terminus for any vent. When the drainage system is more than 4 branch intervals in height, a relief vent is required on the branch connection between the fixtures vented with an air admittance valve and the drainage stack or a positive air pressure attenuator

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must be installed on the stack with an air admittance valve installed at the top of the stack. One positive air pressure attenuator is required at the base of a stack for a 10 story building.

**Residential  
Project:**

The building being analyzed for cost comparison is a 10 story residential building. There are 45 dwelling units in the building. Five of the units are two story units, located on every other floor.

The dwelling units vary in number of bedrooms and number of bathrooms. Some units have automatic clothes washers. There are 7 drainage and vent stack arrangements in the building. The stacks are labeled as Stack S1 through S7. The DWV riser diagrams for each stack appear in Appendix A.

The first seven drawings show the venting arrangement without the use of air admittance valves. The second seven stacks are indicated with the letter “a” after the stack name. These stacks are shown with venting using air admittance valves and positive air pressure attenuators.

**Engineering  
Design:**

High-rise plumbing is unique, in that the plumbing piping is run vertically, rather than horizontally. This is done to minimize the piping to the fixtures on each floor. The venting system relies on a vent stack being in close proximity to the drainage stack. This minimizes the amount of vent piping for the plumbing fixtures.

The drainage and vent system for high-rise plumbing was designed in accordance with the International Plumbing Code. The plumbing fixtures are vented using the most economical venting arrangements. For many bathrooms, the venting system used is a horizontal wet vent. For laundry rooms, the fixtures are common vented. Stack S2 is vented by a waste stack vent. This is a single stack arrangement with fixtures connecting independently to the stack.

For the venting systems using air admittance valves and positive air pressure attenuators, the vents on each floor level terminate to Studor Mini Vent air admittance valves. At the base of the stack, a Studor PAPA positive air pressure attenuator is installed on the drainage stack, below the lowest horizontal branch and a minimum of two feet above the building drain. The top of the drainage stack terminates to a Studor Maxi Vent air admittance valve. With the installation of a positive air pressure attenuator, a companion vent stack is not required because Stack S2 serves as the stack with a vent to the outdoors. This is the one vent to the

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outdoors as required when using air admittance valves. As a result, there is no difference in the cost of Stack 2 between using air admittance valves and not using air admittance valves.

The piping material selected for the vent system is PVC plastic pipe. The fittings used are PVC plastic fittings.

## **Cost and Labor**

**Evaluation:** The cost of the vent system includes the material costs and labor for installing the system. Since labor costs vary, the labor is identified in man hours to install the system. The cost of the drainage system is not included in the analysis.

The material prices were taken from the Bradford Price Book. The price column used was the sell price. This is the price recommended by the price book for a contractor to charge a customer for the material. The price for the Studor air admittance valve is the list price published by Studor. This is also the price that a contractor would charge a customer. The cost of a Studor air admittance valve includes an adapter fitting for connecting the valve to the PVC plastic pipe.

It should be noted that plumbing contractors receive a discount off of list price for pipe and fittings. The discounts for piping material and fittings vary based on the type of material, number of fittings, and volume of purchase.

The PHCC-NA Labor Calculator III was selected for establishing labor rates. It should be noted that the labor associated with the installation of the pipe includes the labor required to cut the pipe, prepare the pipe, drill the holes, and hang the pipe. The fitting labor rate includes the preparation and joining of the fitting. The labor rates are shown in man hours of labor.

The breakdown in the material costs and labor rates for each stack is found in Appendix B. The tables are identified as Table A through Table N. Table A identifies the cost and labor for Stack S1. Table B identifies the cost and labor for Stack S1a. This is the pattern used for all of the remaining stacks.

## **Cost and Labor**

**Comparison:** Table 1 lists the costs and labor rate for each stack. The totals for all of the stacks are summarized at the bottom of the table. The material costs for the venting system without the use of air admittance valves is \$18,506. The labor required to install the system amounts to 445.1 hours of labor.

The material costs for the venting system with the use of air admittance valves is \$8,751. The labor required to install the system amounts to 67.07 hours of labor.

**Table 1**  
**Total Vent System Material and Labor List**

Stack No.	Stacks Without AAVs		Stack No.	Stacks With AAVs and PAPAs	
	Material Costs	Total Labor		Material Costs	Total Labor
1	\$3,841	108.10	1a	\$1,644	14.65
2	\$546	1.00	2a	\$546	1.00
3	\$2,989	68.60	3a	\$1,320	10.40
4	\$3,025	80.36	4a	\$1,289	10.00
5	\$2,802	59.66	5a	\$1,320	10.40
6	\$1,742	30.10	6a	\$986	5.97
7	\$3,561	97.28	7a	\$1,645	14.65
<b>Total</b>	<b>\$18,506</b>	<b>445.10</b>	<b>Total</b>	<b>\$8,751</b>	<b>67.07</b>

Table 2 lists the difference between the material costs and the labor required to install the two venting systems. Also listed is the percentage of savings with the use of air admittance valves. The material savings by using air admittance valves is \$9,755, which is a savings of 52.7 percent. The labor savings by using air admittance valves is 378.03 hours, which is a savings fo 84.9 percent.

**Table 2**  
**Difference Between Stacks Without AAVs and Stacks With AAVs**

<b>Item</b>	<b>Stacks Without AAVs</b>	<b>Stacks With AAVs and PAPAs</b>	<b>Savings With AAV and PAPA</b>	<b>Percentage Difference</b>
Material	\$18,506	\$8,751	\$9,755	52.7%
Labor	445.10	67.07	378.03	84.9%

The labor rate established by the plumbing contractor varies. Table 3 provides total costs using various labor rates that range from \$65 per hour to \$165 per hour. The material and labor costs from Table 1 are used to calculate the total cost of installation for the venting system.

**Table 3**  
**Total Cost of Venting System Installation**  
**At Various Labor Rates**

<b>Labor Rate (per hr)</b>	<b>Without AAVs</b>	<b>With AAVs and PAPAs</b>	<b>Cost Difference</b>	<b>Percent Difference</b>
\$65.00	\$47,437.34	\$13,110.49	\$34,326.85	72.4%
\$75.00	\$51,888.34	\$13,781.19	\$38,107.15	73.4%
\$90.00	\$58,564.84	\$14,787.24	\$43,777.60	74.8%
\$100.00	\$63,015.84	\$15,457.94	\$47,557.90	75.5%
\$125.00	\$74,143.34	\$17,134.69	\$57,008.65	76.9%
\$150.00	\$85,270.84	\$18,811.44	\$66,459.40	77.9%
\$165.00	\$91,947.34	\$19,817.49	\$72,129.85	78.4%

The cost savings shown in Table 3 range from 72.4 percent to 78.4 percent. More than half of the savings is in material cost. A higher percentage of savings is in the labor to install the system. Where a greater percentage of savings is in the labor, the higher the labor rate, the greater the savings for the total installed cost of the venting system.

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**Conclusions:** The use of air admittance valves and positive air pressure attenuators on the venting system for the analyzed 10 story residential high-rise building resulted in savings on the cost of the installation. The total savings of installed cost of the venting system was greater than 70 percent.

The only stack that did not provide a savings with the use of air admittance valves was Stack 2. This stack was vented by a waste stack vent, which is a unique single stack venting system. A minimum of one vent must connect to the outdoors. This stack provides the vent to the outdoors.

Every other stack in the building could facilitate the use of air admittance valves and positive air pressure attenuators. Each stack using air admittance valves and a positive air pressure attenuator resulted in material and labor savings. The material savings resulted in the elimination of the vent stack, thus using less vent piping and fittings. The labor savings was the savings associated with the reductions in piping that needed to be installed.

The actual cost savings for any high-rise building utilizing air admittance valves and positive air pressure attenuators will be dependent on the labor rate, the material discounts for the plumbing contractor, and the bidding process for the project. With the exception of specialized single stack venting systems, the use of air admittance valves and positive air pressure attenuators will result in a savings in the cost of installation for the venting system.

**Certification:** This report was prepared by Julius Ballanco, P.E., President, JB Engineering and Code Consulting, P.C., registered as a Professional Engineer in the State of Indiana, license number PE60900631. JB Engineering and Code Consulting, P.C. is a registered Engineering Professional Corporation in the State of Indiana, license number PC50910000.

Respectfully submitted,



Julius Ballanco, P.E., CPD, FASPE  
President

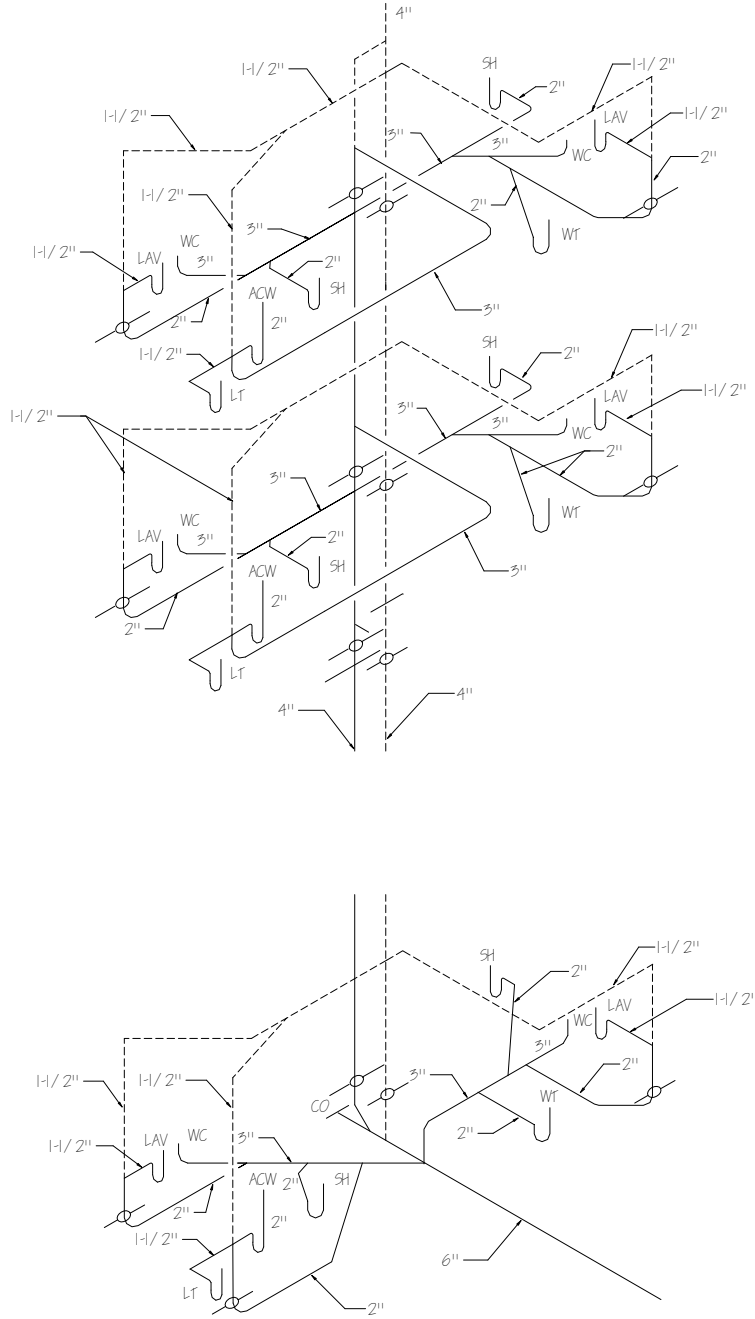
JB/jb

Stack S1  
Venting without Air Admittance Valves

10th FLOOR

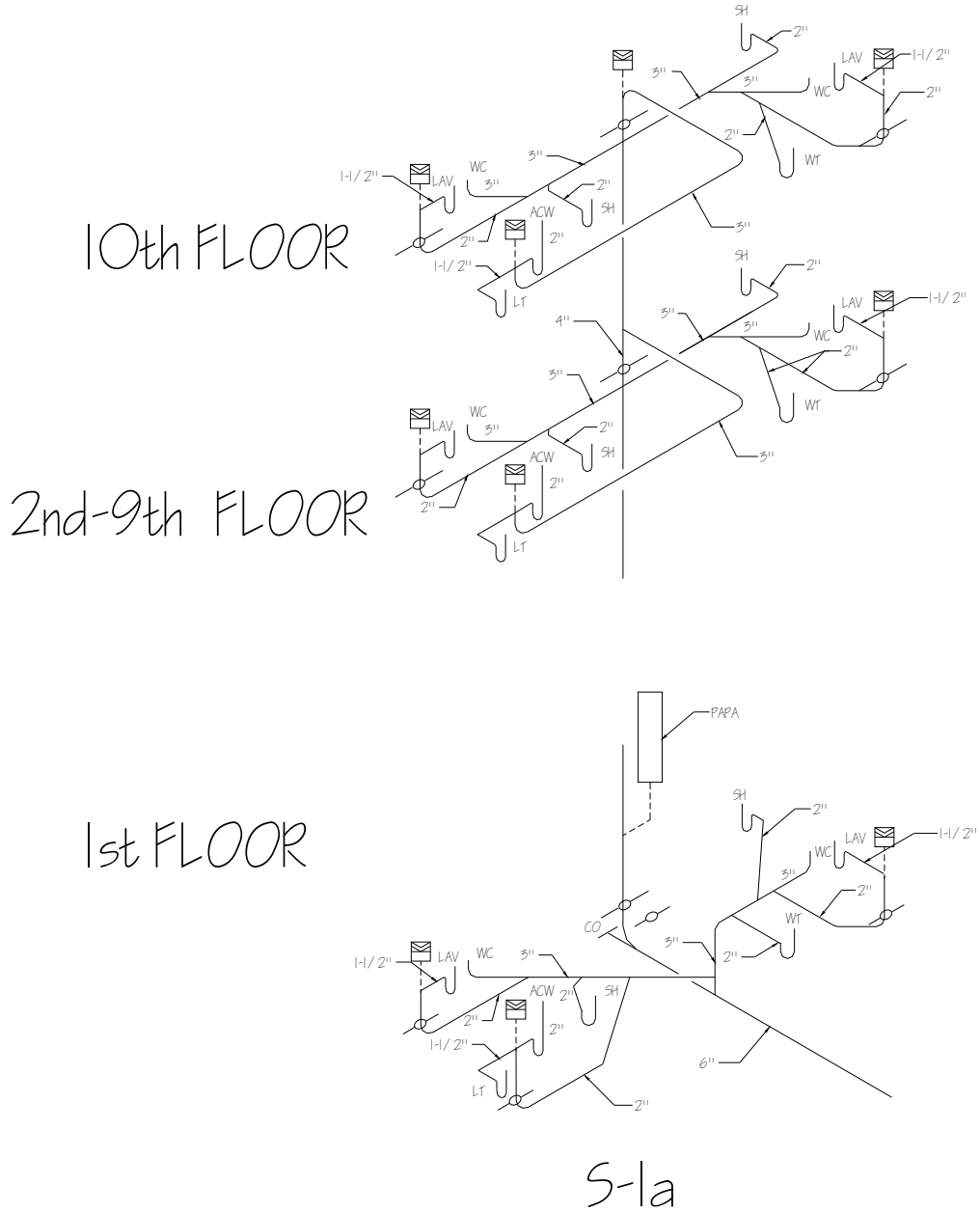
9th FLOOR

1st FLOOR



S-1

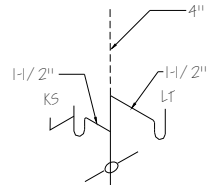
Stack S1a  
Venting with Air Admittance Valves



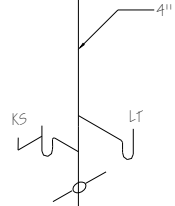


Stack S2  
Venting without Air Admittance Valves

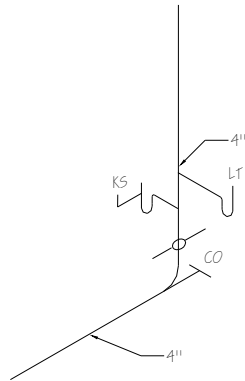
10th FLOOR



9th FLOOR



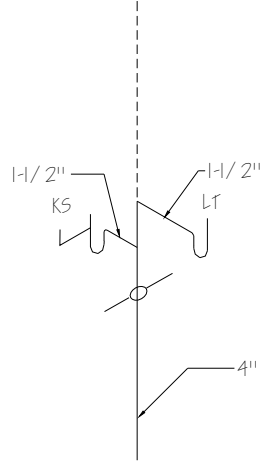
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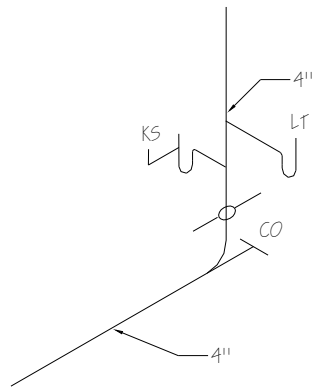
S-2

Stack S2a  
Venting with Air Admittance Valves

2nd-10th FLOOR



1st FLOOR



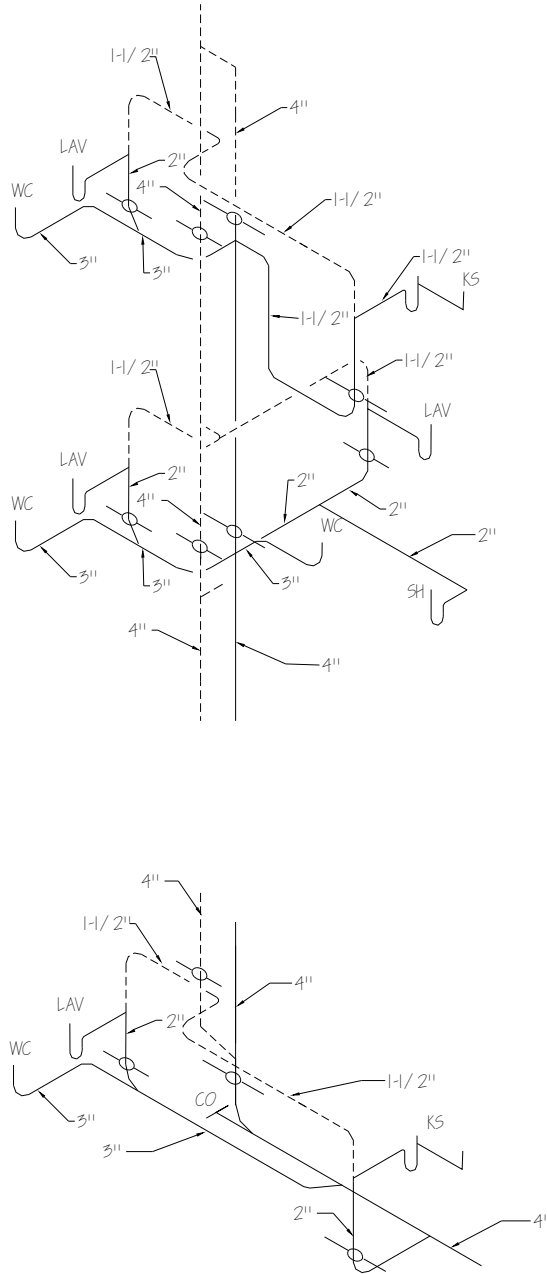
S-2a

Stack S3  
Venting without Air Admittance Valves

10th FLOOR

9th FLOOR

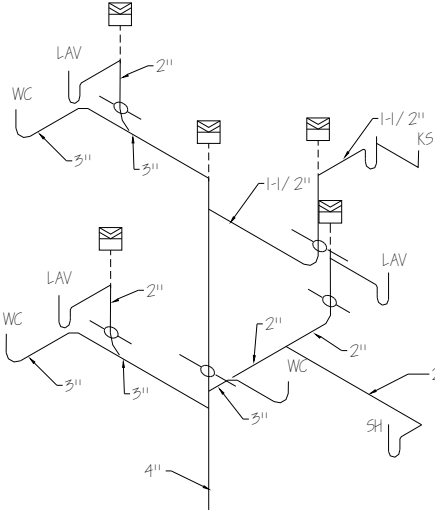
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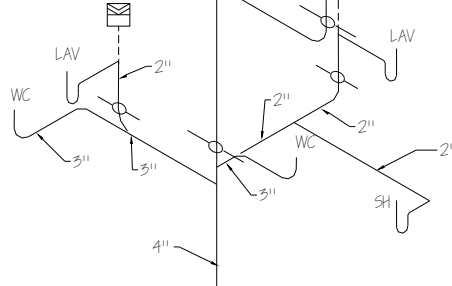
S-3

Stack S3a  
Venting with Air Admittance Valves

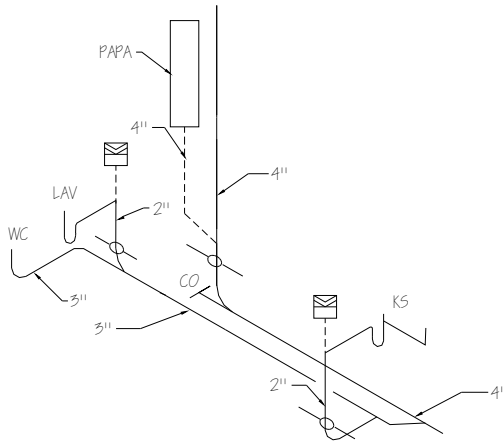
3rd-10th FLOOR



2nd-9th FLOOR



1st FLOOR



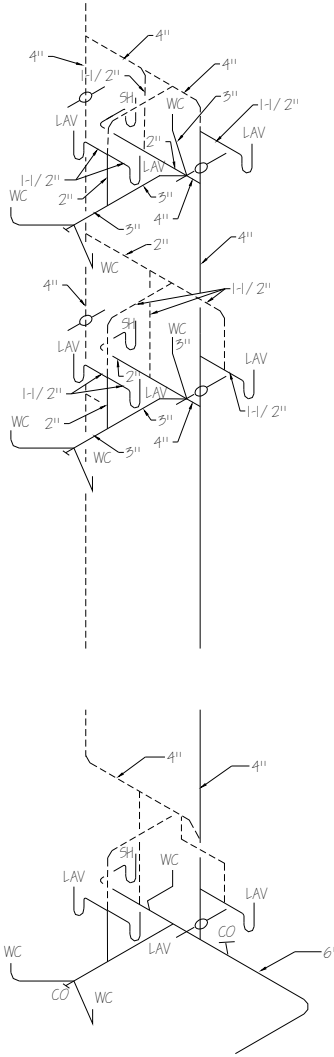
S-3a

Stack S4  
Venting without Air Admittance Valves

10th FLOOR

9th FLOOR

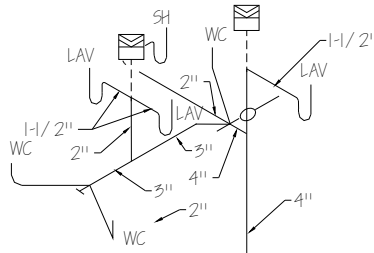
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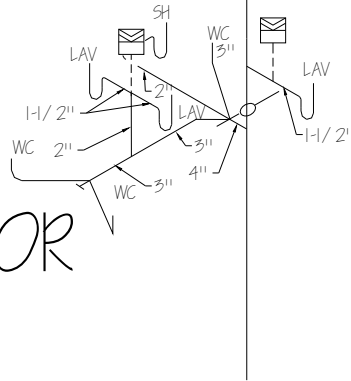
S-4

Stack S4a  
Venting with Air Admittance Valves

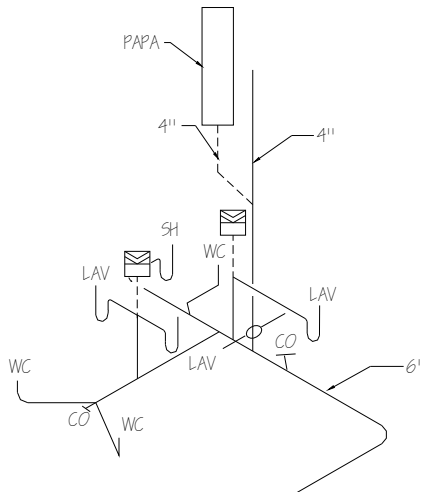
10th FLOOR



2nd-9th FLOOR



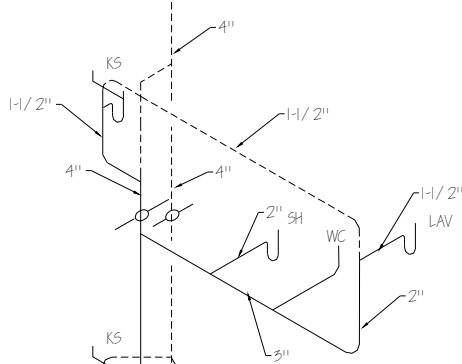
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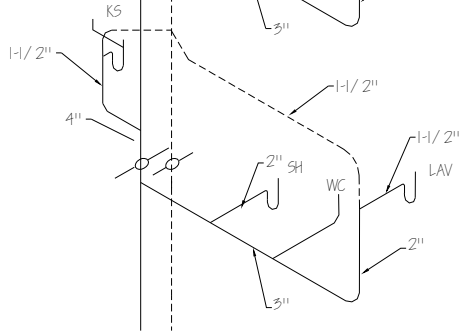
S-4a

Stack S5  
Venting without Air Admittance Valves

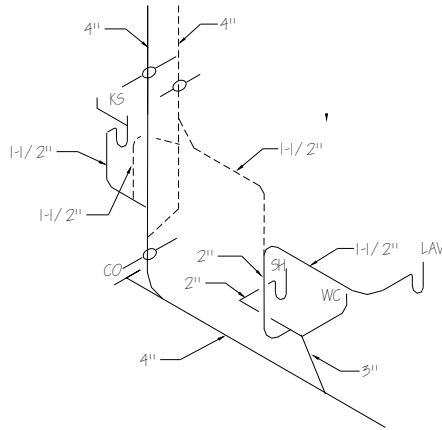
10th FLOOR



9th FLOOR



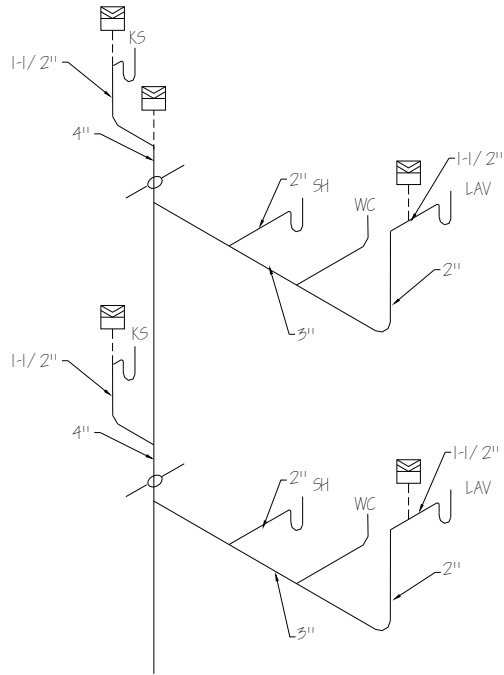
1st FLOOR



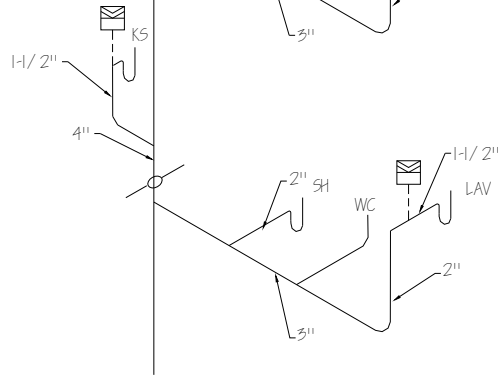
S-5

Stack S5a  
Venting with Air Admittance Valves

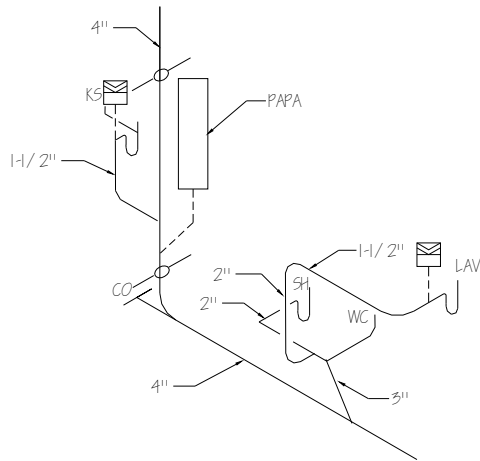
10th FLOOR



2nd-9th FLOOR



1st FLOOR



S-5a

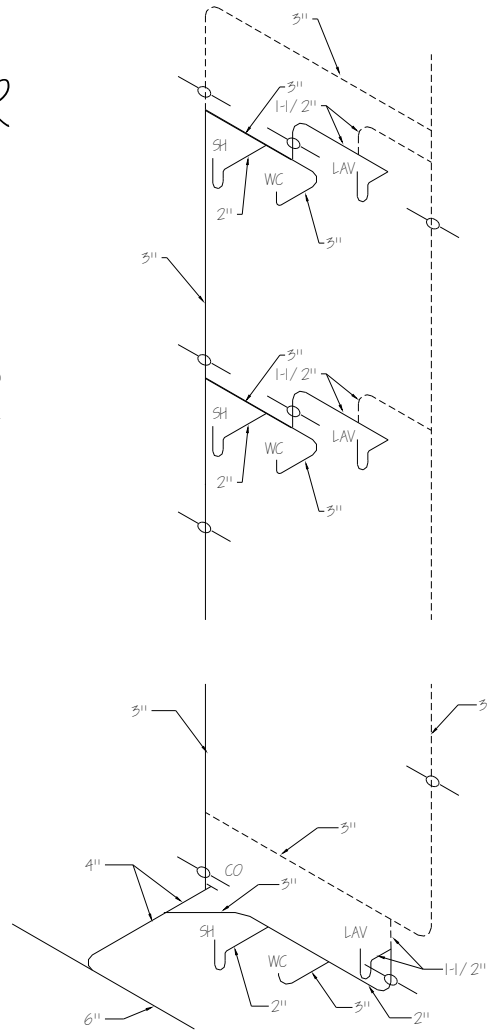


Stack S6  
Venting without Air Admittance Valves

10th FLOOR

9th FLOOR

1st FLOOR

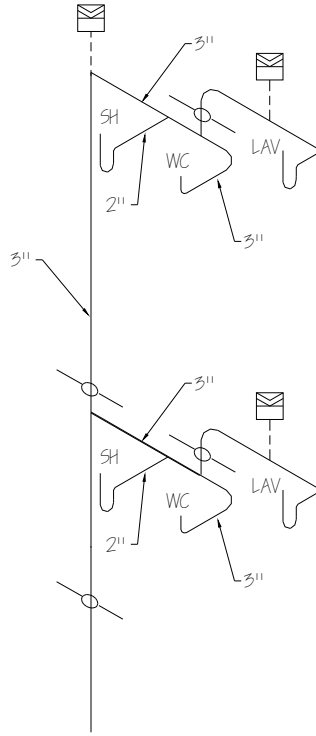


S-6

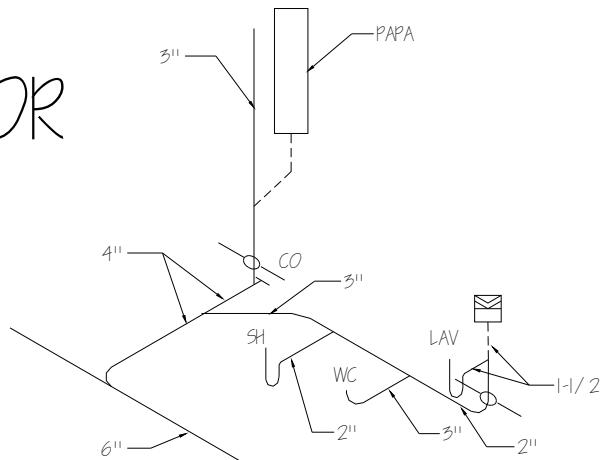
Stack S6a  
Venting with Air Admittance Valves

10th FLOOR

2nd-9th FLOOR



1st FLOOR



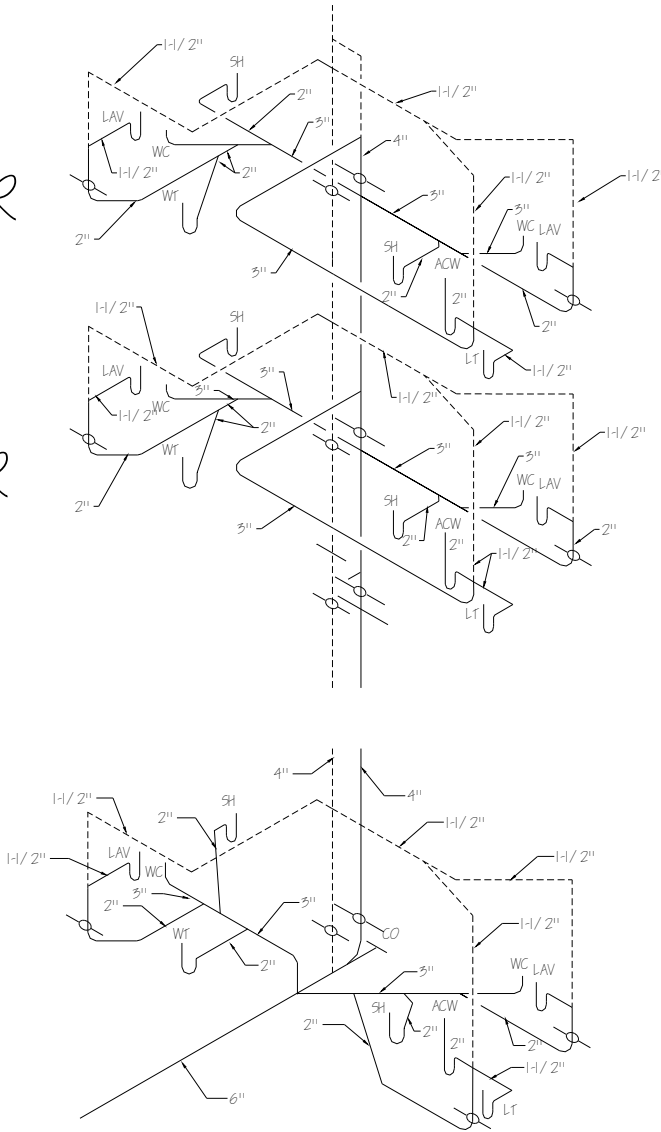
S-6a

Stack S7  
Venting without Air Admittance Valves

10th FLOOR

9th FLOOR

1st FLOOR



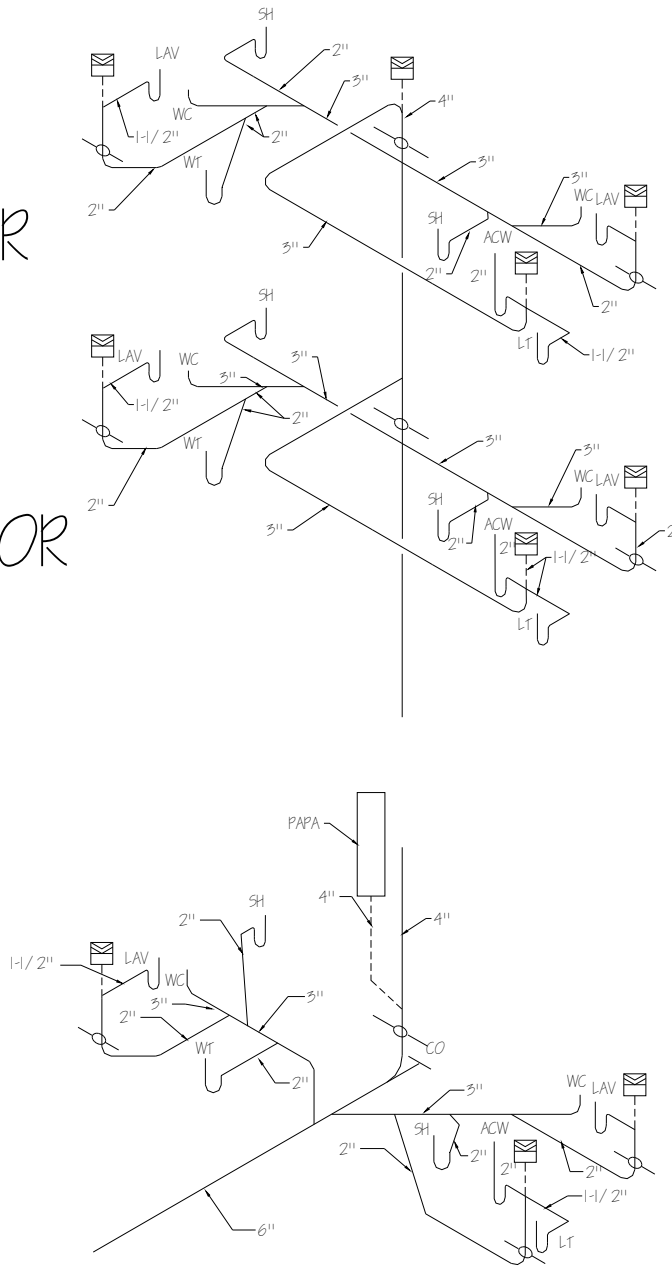
S-7

Stack S7a  
Venting with Air Admittance Valves

10th FLOOR

2nd-9th FLOOR

1st FLOOR



S-7a

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**Table A**  
**Stack S1 Vent System Material and Labor List**

<b>Qty</b>	<b>Vent System Material List</b>	<b>Unit Cost</b>	<b>Total Cost</b>	<b>Unit Labor</b>	<b>Total Labor</b>
110	4" PVC Plastic Pipe	\$4.60	\$506.00	0.10	11.00
770	1-1/2" PVC Plastic Pipe	\$1.24	\$954.80	0.05	38.50
1	4" PVC 90° DWV Elbows	\$32.51	\$32.51	0.88	0.88
1	4" PVC Sanitary Tees	\$44.15	\$44.15	1.32	1.32
10	4" x 2" PVC Double Sanitary Tees	\$71.76	\$717.60	1.76	17.60
20	2" x 1-1/2" PVC Reducers	\$5.12	\$102.40	0.44	8.80
10	1-1/2" PVC Wye	\$12.13	\$121.30	0.60	6.00
50	1-1/2" PVC 90° Vent Elbows	\$7.55	\$377.50	0.40	20.00
10	1-1/2" PVC 45° Vent Elbows	\$3.48	\$34.80	0.40	4.00
1	4" Roof Penetration	\$500.00	\$500.00	0.00	0.00
9	4" Floor Penetration	\$50.00	\$450.00	0.00	0.00
<b>Total</b>			<b>\$3,841.06</b>		<b>108.10</b>

**Table B**  
**Stack S1a Vent System Material and Labor List**

<b>Qty</b>	<b>Vent System Material List</b>	<b>Unit Cost</b>	<b>Total Cost</b>	<b>Unit Labor</b>	<b>Total Labor</b>
5	4" PVC Plastic Pipe	\$4.60	\$23.00	0.10	0.50
15	1-1/2" PVC Plastic Pipe	\$1.24	\$18.60	0.05	0.75
30	Studor Mini AAV	\$31.80	\$954.00	0.40	12.00
1	Studor Maxi AAV	\$49.10	\$49.10	0.40	0.40
1	Studor PAPA	\$599.95	\$599.95	1.00	1.00
<b>Total</b>			<b>\$1,644.65</b>		<b>14.65</b>

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**Table C**  
**Stack S2 Vent System Material and Labor List**

<b>Qty</b>	<b>Vent System Material List</b>	<b>Unit Cost</b>	<b>Total Cost</b>	<b>Unit Labor</b>	<b>Total Labor</b>
10	4" PVC Plastic Pipe	\$4.60	\$46.00	0.10	1.00
1	4" Roof Penetration	\$500.00	\$500.00	0.00	0.00
<b>Total</b>			\$546.00		1.00

**Table D**  
**Stack S2a Vent System Material and Labor List**

<b>Qty</b>	<b>Vent System Material List</b>	<b>Unit Cost</b>	<b>Total Cost</b>	<b>Unit Labor</b>	<b>Total Labor</b>
10	4" PVC Plastic Pipe	\$4.60	\$46.00	0.10	1.00
1	4" Roof Penetration	\$500.00	\$500.00	0.00	0.00
<b>Total</b>			\$546.00		1.00

**Table E**  
**Stack S3 Vent System Material and Labor List**

<b>Qty</b>	<b>Vent System Material List</b>	<b>Unit Cost</b>	<b>Total Cost</b>	<b>Unit Labor</b>	<b>Total Labor</b>
110	4" PVC Plastic Pipe	\$4.60	\$506.00	0.10	11.00
300	1-1/2" PVC Plastic Pipe	\$1.24	\$372.00	0.05	15.00
1	4" PVC 90° DWV Elbows	\$32.51	\$32.51	0.88	0.88
1	4" PVC Sanitary Tees	\$44.15	\$44.15	1.32	1.32
10	4" x 2" PVC Double Sanitary Tees	\$71.76	\$717.60	1.76	17.60
20	2" x 1-1/2" PVC Reducers	\$5.12	\$102.40	0.44	8.80
35	1-1/2" PVC 90° Vent Elbows	\$7.55	\$264.25	0.40	14.00
1	4" Roof Penetration	\$500.00	\$500.00	0.00	0.00
9	4" Floor Penetration	\$50.00	\$450.00	0.00	0.00
<b>Total</b>			<b>\$2,988.91</b>		<b>68.60</b>

**Table F**  
**Stack S3a Vent System Material and Labor List**

<b>Qty</b>	<b>Vent System Material List</b>	<b>Unit Cost</b>	<b>Total Cost</b>	<b>Unit Labor</b>	<b>Total Labor</b>
5	4" PVC Plastic Pipe	\$4.60	\$23.00	0.10	0.50
10	1-1/2" PVC Plastic Pipe	\$1.24	\$12.40	0.05	0.50
20	Studor Mini AAV	\$31.80	\$636.00	0.40	8.00
1	Studor Maxi AAV	\$49.10	\$49.10	0.40	0.40
1	Studor PAPA	\$599.95	\$599.95	1.00	1.00
<b>Total</b>			<b>\$1,320.45</b>		<b>10.40</b>

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**Table G**  
**Stack S4 Vent System Material and Labor List**

Qty	Vent System Material List	Unit Cost	Total Cost	Unit Labor	Total Labor
116	4" PVC Plastic Pipe	\$4.60	\$533.60	0.10	11.60
40	2" PVC Plastic Pipe	\$1.62	\$64.80	0.06	2.40
340	1-1/2" PVC Plastic Pipe	\$1.24	\$421.60	0.05	17.00
2	4" PVC 90° DWV Elbows	\$32.51	\$65.02	0.88	1.76
1	4" PVC Sanitary Tees	\$44.15	\$44.15	1.32	1.32
9	4" x 2" PVC Sanitary Tees	\$39.47	\$355.23	1.32	11.88
4	4" x 1-1/2" PVC Sanitary Tees	\$47.54	\$190.16	1.40	5.60
18	2" x 1-1/2" PVC Sanitary Tees	\$8.35	\$150.30	0.66	11.88
8	2" x 1-1/2" PVC Reducers	\$5.12	\$40.96	0.44	3.52
9	1-1/2" PVC Sanitary Tees	\$6.43	\$57.87	0.60	5.40
20	1-1/2" PVC 90° Vent Elbows	\$7.55	\$151.00	0.40	8.00
1	4" Roof Penetration	\$500.00	\$500.00	0.00	0.00
9	4" Floor Penetration	\$50.00	\$450.00	0.00	0.00
<b>Total</b>			<b>\$3,024.69</b>		<b>80.36</b>

**Table H**  
**Stack S4a Vent System Material and Labor List**

Qty	Vent System Material List	Unit Cost	Total Cost	Unit Labor	Total Labor
5	4" PVC Plastic Pipe	\$4.60	\$23.00	0.10	0.50
10	1-1/2" PVC Plastic Pipe	\$1.24	\$12.40	0.05	0.50
19	Studor Mini AAV	\$31.80	\$604.20	0.40	7.60
1	Studor Maxi AAV	\$49.10	\$49.10	0.40	0.40
1	Studor PAPA	\$599.95	\$599.95	1.00	1.00
<b>Total</b>			<b>\$1,288.65</b>		<b>10.00</b>



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**Table I**  
**Stack S5Vent System Material and Labor List**

<b>Qty</b>	<b>Vent System Material List</b>	<b>Unit Cost</b>	<b>Total Cost</b>	<b>Unit Labor</b>	<b>Total Labor</b>
110	4" PVC Plastic Pipe	\$4.60	\$506.00	0.10	11.00
250	1-1/2" PVC Plastic Pipe	\$1.24	\$310.00	0.05	12.50
2	4" PVC 90° DWV Elbows	\$32.51	\$65.02	0.88	1.76
10	4" x 2" PVC Double Sanitary Tees	\$71.76	\$717.60	1.76	17.60
20	2" x 1-1/2" PVC Reducers	\$5.12	\$102.40	0.44	8.80
20	1-1/2" PVC 90° Vent Elbows	\$7.55	\$151.00	0.40	8.00
1	4" Roof Penetration	\$500.00	\$500.00	0.00	0.00
9	4" Floor Penetration	\$50.00	\$450.00	0.00	0.00
<b>Total</b>			<b>\$2,802.02</b>		<b>59.66</b>

**Table J**  
**Stack S5a Vent System Material and Labor List**

<b>Qty</b>	<b>Vent System Material List</b>	<b>Unit Cost</b>	<b>Total Cost</b>	<b>Unit Labor</b>	<b>Total Labor</b>
5	4" PVC Plastic Pipe	\$4.60	\$23.00	0.10	0.50
10	1-1/2" PVC Plastic Pipe	\$1.24	\$12.40	0.05	0.50
20	Studor Mini AAV	\$31.80	\$636.00	0.40	8.00
1	Studor Maxi AAV	\$49.10	\$49.10	0.40	0.40
1	Studor PAPA	\$599.95	\$599.95	1.00	1.00
<b>Total</b>			<b>\$1,320.45</b>		<b>10.40</b>

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**Table K**  
**Stack S6 Vent System Material and Labor List**

<b>Qty</b>	<b>Vent System Material List</b>	<b>Unit Cost</b>	<b>Total Cost</b>	<b>Unit Labor</b>	<b>Total Labor</b>
120	3" PVC Plastic Pipe	\$3.26	\$391.20	0.08	9.60
100	1-1/2" PVC Plastic Pipe	\$1.24	\$124.00	0.05	5.00
10	3" x 1-1/2" PVC Sanitary Tees	\$17.57	\$175.70	1.05	10.50
2	3" PVC DWV Elbow	\$16.50	\$33.00	0.70	1.40
9	1-1/2" PVC 90° Vent Elbows	\$7.55	\$67.95	0.40	3.60
1	3" Roof Penetration	\$500.00	\$500.00	0.00	0.00
9	3" Floor Penetration	\$50.00	\$450.00	0.00	0.00
<b>Total</b>			<b>\$1,741.85</b>		<b>30.10</b>

**Table L**  
**Stack S6a Vent System Material and Labor List**

<b>Qty</b>	<b>Vent System Material List</b>	<b>Unit Cost</b>	<b>Total Cost</b>	<b>Unit Labor</b>	<b>Total Labor</b>
4	3" PVC Plastic Pipe	\$3.26	\$13.04	0.08	0.32
5	1-1/2" PVC Plastic Pipe	\$1.24	\$6.20	0.05	0.25
10	Studor Mini AAV	\$31.80	\$318.00	0.40	4.00
1	Studor Maxi AAV	\$49.10	\$49.10	0.40	0.40
1	Studor PAPA	\$599.95	\$599.95	1.00	1.00
<b>Total</b>			<b>\$986.29</b>		<b>5.97</b>

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**Table M**  
**Stack S7 Vent System Material and Labor List**

<b>Qty</b>	<b>Vent System Material List</b>	<b>Unit Cost</b>	<b>Total Cost</b>	<b>Unit Labor</b>	<b>Total Labor</b>
110	4" PVC Plastic Pipe	\$4.60	\$506.00	0.10	11.00
580	1-1/2" PVC Plastic Pipe	\$1.24	\$719.20	0.05	29.00
1	4" PVC 90° DWV Elbows	\$32.51	\$32.51	0.88	0.88
10	4" x 2" PVC Double Sanitary Tees	\$71.76	\$717.60	1.76	17.60
20	2" x 1-1/2" PVC Reducers	\$5.12	\$102.40	0.44	8.80
10	1-1/2" PVC Wye	\$12.13	\$121.30	0.60	6.00
50	1-1/2" PVC 90° Vent Elbows	\$7.55	\$377.50	0.40	20.00
10	1-1/2" PVC 45° Vent Elbows	\$3.48	\$34.80	0.40	4.00
1	4" Roof Penetration	\$500.00	\$500.00	0.00	0.00
9	4" Floor Penetration	\$50.00	\$450.00	0.00	0.00
<b>Total</b>			<b>\$3,561.31</b>		<b>97.28</b>

**Table N**  
**Stack S7a Vent System Material and Labor List**

<b>Qty</b>	<b>Vent System Material List</b>	<b>Unit Cost</b>	<b>Total Cost</b>	<b>Unit Labor</b>	<b>Total Labor</b>
5	4" PVC Plastic Pipe	\$4.60	\$23.00	0.10	0.50
15	1-1/2" PVC Plastic Pipe	\$1.24	\$18.60	0.05	0.75
30	Studor Mini AAV	\$31.80	\$954.00	0.40	12.00
1	Studor Maxi AAV	\$49.10	\$49.10	0.40	0.40
1	Studor PAPA	\$599.95	\$599.95	1.00	1.00
<b>Total</b>			<b>\$1,644.65</b>		<b>14.65</b>